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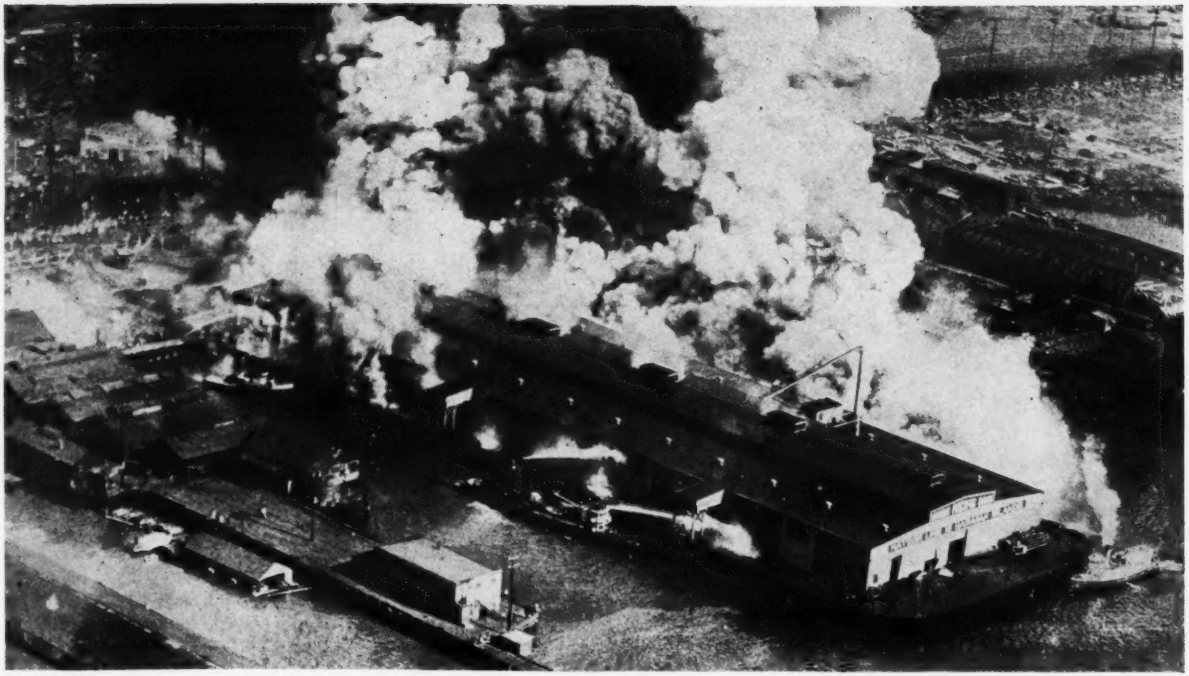

International.

Sprinklers saved this Seattle pier, despite the handicap of large undivided area, and the fact that the fire started in the unsprinklered space below the pier deck. **(See report on page 174.)**

The Quarterly

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The Boston Fire Survey. The undertaking of the City of Boston to ascertain by a fire survey sponsored by itself just what the causes may be of its excessive fire waste and how it may be reduced is unique in the history of municipalities in America. The recent authorization of the publication of the survey by the city as a public document will put it in shape to be of service to other cities confronted by the fire waste problem. It is no small compliment to our Association that the government of its home city should call upon the N.F.P.A. to conduct the technical part of this survey which is now completed. While $3000 subscribed by the city to our field service fund in recognition of our coöperation does not cover the Field Service Department's contribution of time and expense in conducting this project, it is nevertheless the first substantial official recognition by a large city of the value of the service we are equipped to render.

The sponsors of this survey, a committee of distinguished citizens appointed by the mayor, are not insensible to the fact that time will be required, and sustained, intelligent activity as well, to advance the improvements and corrections advocated in it by our engineers, and will undoubtedly insist on action on the recommendations of the report. Another helpful agency should be the recently organized Fire Prevention Committee of the Boston Chamber of Commerce, which awaits the publication of the survey before projecting its program.

* * * * *

Conference on Spontaneous Ignition. The conference on spontaneous heating and ignition called by the Association for November 14 and 15, to be held at the Hotel Raleigh, Washington, D. C., promises to be an exceedingly interesting and fruitful meeting. This is the outgrowth of action taken at the last annual convention of the Association, when a small group of those particularly concerned gathered for an informal discussion of the general problem.

Fires caused by spontaneous ignition are responsible for enormous annual losses. Statistics compiled by the National Board of Fire Underwriters

on the basis of losses paid by the insurance companies reporting to its Actuarial Bureau show an annual fire loss due to this cause of some $15,000,000. This represents but a fraction of the total, which is greatly increased by the fire losses paid by fire insurance companies not reporting to the Actuarial Bureau and by uninsured losses. Likewise a considerable proportion of the losses from unknown causes, which reach nearly $200,000,000 annually, would doubtless be attributed to spontaneous ignition if the actual cause could be determined. Closely related to fire losses is the damage to agricultural and industrial products when spontaneous heating occurs which is arrested short of the stage of actual ignition or combustion. There is no basis on which to make any estimate of the aggregate losses of this character, but it is obvious that the total is very large.

During the past few years a number of agencies have been engaged in research as to the causes and methods of control of spontaneous heating and ignition. While much important information has been developed by such research work, the field has as yet scarcely been scratched and a great deal of additional technical information will be required before fire prevention agencies will have available information to permit the successful control of this hazard. The conference to be held in Washington will have as its purpose the coördination of the various activities on this subject and the development of a program of fundamental research through which it is felt that much more effective progress can be made than has been possible previously with the unrelated individual efforts in various specialized phases of this large field.

Replies to preliminary announcements of this conference indicate a very widespread interest on the part of various departments of the United States Government, insurance, technical and industrial interests. All members of the N.F.P.A. and others interested are invited to attend.

* * * * *

Fifty Years of Electric Light. October 21, 1879, was the date on which Thomas A. Edison presented to the world his wonderful invention of the incandescent lamp. In the intervening half century this lamp has completely revolutionized the artificial lighting of the world. The fifty years of development of Mr. Edison's invention have been significant years to the N.F.P.A. The National Electrical Code was evolved and has been maintained to make electric lighting safe. It is interesting that our only living honorary members, C. M. Goddard, F. E. Cabot and H. O. Lacount, made their greatest contribution to the N.F.P.A. and to society by the painstaking, earnest attention they gave to the electrical hazard and the development of the code now so universally accepted. The inventor is not primarily a conservationist, however his inventions may work out in service. Mr. Edison determined how his invention would work. That was his great contribution. Its

effect upon public safety was left to others to determine, and hundreds of able and devoted men were compelled to review and revise their electrical engineering education in order to keep pace in their special fields with the development of electric lighting. The world stared at Mr. Edison's invention but accepted it with due conservatism. Many of us remember how slowly the gas fixtures disappeared. The new light had to demonstrate its reliability. This it has now done, and there are few men who would withhold from Mr. Edison a full meed of praise and admiration for his great contribution to the comfort and the beauty of the world.

* * * * *

Fire Prevention Week, 1929. Fire Prevention Week, 1929, has again surpassed all expectations in character and extent of its observance, judged by pre-campaign correspondence. Under the leadership of the energetic and enthusiastic Chairman of our Committee on Fire Prevention and Clean-up Campaign, Mr. T. Alfred Fleming, communities throughout the United States and Canada are devoting a degree of attention to this annual observance which is truly remarkable. Fire Prevention Week has frequently been referred to as being merely a passing phase which would soon lose force through competition with various other national "weeks" promoted largely for advertising purposes. Another point to be considered is that fire prevention activities should not be limited by any means to a single week, but should be continued throughout the entire year. Fire Prevention Week, however, even in a community where a continuous campaign is carried on, does have a definite place in the focusing of public interest in fire prevention and as the starting point for a year-round campaign. Fire Prevention Week in 1929 shows no indication of any diminution of interest in this annual observance, but rather an increasingly widespread participation in the campaign. Fire Prevention Week seems to be established as a permanent international institution.

* * * * *

Two Ways Out. The Detroit Night Club fire reported in detail on another page of this QUARTERLY is a glaring example of the neglect of common sense fire prevention precautions. The results of this fire were so horrible and there were so many contributing factors that the importance of what appears to be the primary lesson of this fire may not be fully realized.

It is a common rule of life safety from fire that there should always be two ways of escape; in the language of the Building Exits Code, the official standard of the Association, "From every building or section there shall always be two ways of escape, exits being as remote from each other as practicable." In the Detroit case there were two doorways leading from the room, but as they were adjacent openings of the same wall they could not

be considered as complying with the provisions of the Building Exits Code. No codes or laws, however rigidly enforced, can take the place of an enlightened viewpoint on fire-safety by owners, architects, inspection authorities and others who have responsibility in such matters. It takes no unusual ability nor technical training to recognize the necessity for a second means of exit and to take steps to put this requirement into effect, but even in public buildings supposedly complying with all the requirements of fire prevention it will frequently be found that an area where people congregate in large numbers has in effect but a single exit. All those interested in fire prevention can render a real public service by keeping this point constantly in mind, and calling to the attention of the appropriate authorities all instances where duplicate exit facilities are not provided.

* * * * *

The N.F.P.A. Film Regulations Substantiated.

Following the Cleveland Clinic fire of May 15, 1929, a Board of the Chemical Warfare Service of the United States Army was appointed for the purpose of investigating conditions incident to this disaster in which one hundred and twenty-three people lost their lives. This investigation covered all phases of the disaster, including a detailed analysis of the methods of film storage employed at this building and the proper practices to be followed for the avoidance of such disasters.

The N.F.P.A. Committee on Hazardous Chemicals and Explosives investigated this hazard shortly after the nitrocellulose X-ray film came into general use and, as a result of extended study by the committee, regulations for the safeguarding of this hazard were adopted by the Association in 1925, and subsequently promulgated by the National Board of Fire Underwriters. These regulations have in the intervening years been urged by the Association as indicating a reasonable and efficient method of minimizing this hazard.

The standing of N.F.P.A. technical committees is so high that there is seldom if ever any occasion to question the validity of their findings, and it was not to be expected in the present instance that the investigation following the Cleveland fire would disclose any serious deficiencies in the previously prepared regulations. The proceedings of the board of the Chemical Warfare Service just published fully substantiate the earlier work of the N.F.P.A. committee and gracefully credit the Association in specific statements such as: "The size of vent for X-ray film storage rooms recommended by the National Fire Protection Association . . . is sufficient to carry off the fumes . . . "

The Model Arson Law.

The model arson law as sponsored by the Fire Marshals Section of the National Fire Protection Association is now in effect in twenty-seven states as a result of the continuous campaign for its enactment carried on since the merger of the Fire Marshals Association of North America with the N.F.P.A. in 1927, when the Fire Marshals Section of the Association was formed. The map below shows the progress of this legislation to date, the states shown in solid black being those where the model law is in effect. In a number of other states existing legislation is partially satisfactory, but these are not indicated on the map, which is designed only to show the states where the model law has been enacted in its entirety.

The campaign will be continued during the coming year, and it is hoped that at the next session of the several state legislatures a substantial number of additional states will be added to the list. The history of the development of the project is reported in the Proceedings (1927, page 166; 1928, page 155; 1929, page 44), and in the News Letter, which has recorded from month to month the adoption of the law in the several states.

Fireman Aitken's Ingenious Exhibit.

A float designed and built by Fireman William Aitken, attached to Engine Co. No. 2 of the Newark (N. J.) Fire Department, picturizing the slogan "Prevent Fire," has won eight baby parade prizes within the last three months in eight different New Jersey municipalities. The prizes were awarded in Orange, Morristown, Passaic, Point Pleasant, Highlands, Asbury Park, Caldwell and Union City, and consisted of five loving cups in silver, a cedar chest, silver fruit bowl, boudoir lamp and $150 in gold.

Through the teachings of fire prevention by Fire Commissioner Charles H. Kenlon, Mr. Aitken conceived the idea of building the float and bringing

A prize-winning float.

it before the public. Next year, if possible, Mr. Aitken hopes to go a step further and build a float typifying fire prevention, but on a much larger scale.

Mr. Aitken's son, Billy, five years old, by right of heritage, does the rescue act on the float. His career started in June when Mr. Aitken entered the float in the Orange baby parade. The float is designed like a house, with fire coming out of the roof. There's a girl in the picture too. She is a beautiful doll-baby calling for help from an upstairs window. The gallant fireman rushes up a ladder to the rescue, puts out the fire and saves the child.

On the float stand a small fire engine, hose cart and chief's car. A hose is attached to a fire hydrant and the nozzle is held by the fireman on the ladder. Billy's two cousins, James McNichols and Edward O'Brien, both of Orange, attired in regulation fire costume, pull the float. A bell and siren ring continuously. The accompanying photograph shows the float and the boys operating it.

The King and the Sprinkler System.

It is fifty years since Mark Twain in his amusing story of his tramp abroad recounted the incident of the use of the fire protection equipment of the Munich theatre to heighten the realism of an operatic performance.

The King of Bavaria is a poet, and has a poet's eccentricities—with the advantage over all other poets of being able to gratify them, no matter what form they may take. He is fond of the opera, but not fond of sitting in the presence of an audience; therefore, it has sometimes occurred, in Munich, that when an opera has been concluded and the players were getting off their paint and finery, a command has come to them to get their paint and finery on again. Presently the King would arrive, solitary and alone, and the players would begin at the beginning and do the entire opera over again with only that one individual in the vast solemn theatre for audience. Once he took an odd freak into his head. High up and out of sight, over the prodigious stage of the court theatre is a maze of interlacing water pipes, so pierced that, in case of fire, innumerable little thread-like streams of water can be caused to descend; and in case of need this discharge can be augmented to a pouring flood. American managers might make a note of that. The King was sole audience. The opera proceeded, it was a piece with a storm in it; the mimic thunder began to mutter, the mimic wind began to wail and sough, and the mimic rain to patter. The King's interest rose higher and higher; it developed into enthusiasm. He cried out:

"It is good, very good, indeed! But I will have real rain! Turn on the water!"

The manager pleaded for a reversal of the command; said it would ruin the costly scenery and the splendid costumes, but the King cried:

"No matter, no matter; I will have real rain! Turn on the water!"

So the real rain was turned on and began to descend in gossamer lances to the mimic flower beds and gravel walks of the stage. The richly-dressed actresses and actors tripped about, singing bravely and pretending not to mind it. The King was delighted—his enthusiasm grew higher. He cried out:

"Bravo, bravo! More thunder, more lightning! Turn on more rain!"

The thunder boomed, the lightning glared, the storm winds raged, the deluge poured down. The mimic royalty on the stage, with their soaked satins clinging to their bodies, slopped around ankle deep in water, warbling their sweetest and best, the fiddlers under the eaves of the stage sawed away for dear life, with the cold overflow spouting down the backs of their necks, and the dry and happy King sat in his lofty box and wore his gloves to ribands applauding.

"More yet!" cried the King; "more yet,—let loose all the thunder, turn on all the water! I will hang the man that raises an umbrella!"

When this most tremendous and effective storm that had ever been produced in any theatre was at last over, the King's approbation was measureless. He cried:

"Magnificent, magnificent! Encore! Do it again!"

But the manager succeeded in persuading him to recall the encore, and said the company would feel sufficiently rewarded and complimented in the mere fact that the encore was desired by his Majesty, without fatiguing him with a repetition to gratify their own vanity.

During the remainder of the act the lucky performers were those whose parts required changes of dress; the others were soaked, bedraggled, an uncomfortable lot, but in the last degree picturesque. The stage scenery was ruined, trap doors were so swollen that they wouldn't work for a week afterwards, the fine costumes were spoiled, and no end of minor damages were done by that remarkable storm.

It was a royal idea—that storm—and royally carried out. But observe the moderation of the King; he did not insist upon his encore. If he had been a gladsome, unreflecting American opera audience, he probably would have had his storm repeated and repeated until he drowned all those people.

It is interesting that in Munich a half century ago the same sort of rude beginning of the sprinkler system should have made its appearance that also appeared in America and that American inventive genius was to develop into the present highly specialized automatic system of fire equipment.

The Study Club Fire.

"Dance for Your Health" was the slogan printed upon the papers of matches distributed at the Study Club, 65 East Vernor Highway, Detroit, prior to the fire which took twenty-two lives and injured forty-five or more people at 1:32 A.M., Friday, September 20, 1929. One of these same matches carelessly discarded by a patron on his way out of the building may have been the cause of the fire. The loss of life and injury occurred on the second floor, where the dance hall and dining room were located. There was no exit at the rear of the building and the occupants were trapped like rats.

Construction and Occupancy.

The building was originally a residence of the better class. In 1913 a two-story rear addition was erected, the building then being occupied by a medical society. The general lay-out of the building is shown by the accompanying plan and photographs (see Figs. 1 and 2).

The original portion of the structure was of ordinary brick joisted construction. The rear portion was of a better grade of construction with metal lath ceilings, wired glass windows, etc. It was in the rear portion on the second story that the loss of life occurred.

The features of construction and arrangement which were primarily responsible for the loss of life were due to the alterations and decorations which had been installed for the night club occupancy. In the prior occupancy the rear of the second floor had been used for a library occupied by a small number of persons. With this occupancy there was no criticism of the exit arrangements or fire-safety. When altered for the night club occupancy all of the windows with the possible exception of one or two windows at each side near the forward end of the hall and one window from the dressing room at the rear, had been blocked off and plastered over, there being no indication from the interior as to the location of the windows. (See Figs. 6 and 7.) Two false windows for decorative purposes located in the rear wall did not coincide with the actual windows. The entire interior was decorated with highly flammable materials. Light wooden lattice work, highly flammable

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Note:—This report has been prepared by Robert S. Moulton, Technical Secretary, N.F.P.A., who visited the scene of the disaster on September 27, 1929. Acknowledgment is made to the Michigan Inspection Bureau, the prosecuting attorney's office, the Detroit fire department, the Building Commissioner, and Mr. Paxton Mendelssohn, Chairman, Fire Prevention Committee, Detroit Board of Commerce, and Mr. Robert Morris, Deputy State Fire Marshal, all of whom coöperated whole-heartedly in making information available. As is frequently the case in fires involving major loss of life, the evidence on some details is conflicting and exact statements cannot be made at this time on certain phases of the fire. It is felt, however, that this report is correct in all essential features.

Fig. 1. The Study Club, 65 East Vernor Highway, Detroit, where twenty-two persons lost their lives and approximately forty-five were seriously injured in the fire which occurred at 1:32 A.M. on September 20, 1929.

cloth, and oak leaves which had been treated with either wax or lacquer to add to their luster, made for an extremely rapid fire. (See Fig. 6.)

With normal ventilation through the windows unavailable it was necessary to provide for some sort of ventilation. Accordingly, a large fan was installed exhausting from the roof space above the dance hall, two openings in the ceiling leading to this space. This fan, some 30 inches in diameter and driven by a three-quarter horse power motor, exhausted the air from the ceiling. No provision, however, was made for ingress of fresh air to the room except by leakage and through the main doorway. It was reported by persons who visited the club prior to the fire that the draft through the corridor was so strong as to cause distinct annoyance while walking through the corridor.

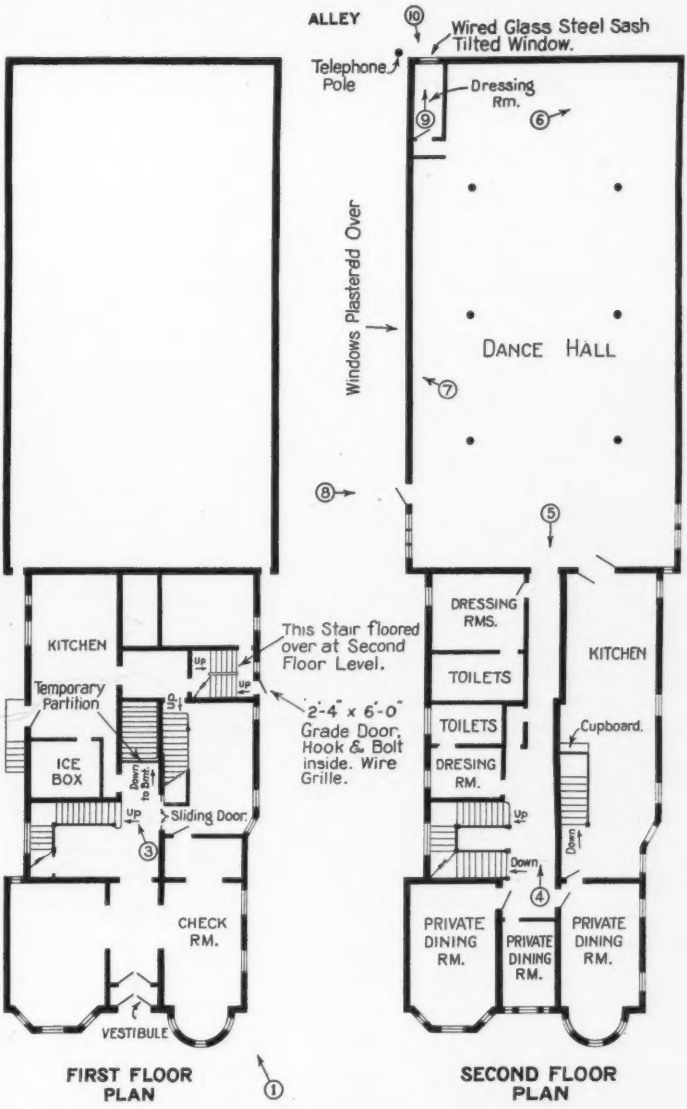


Fig. 2. Sketch plan of the Study Club. Basement, detail rear of the first floor, and third floor of the old portion not shown as these were not involved in the fire. The numbered arrows show the points from which the several photographs were taken.

Plan not drawn to scale. Dimensions of dance hall approximately 42 x 74 ft.

Fig. 3. Bottom of main stairway. Fire started in flammable decorations in the hallway at this point. The stairway, including the balustrade, was completely enclosed in highly flammable cloth decorations set off from the walls by battens, leaving an air space which promoted rapid combustion. The doorway at the right leads to the first floor kitchen.

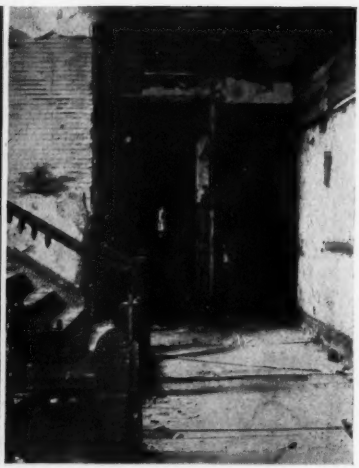


Fig. 4. The stairway at the second floor level. The corridor in the right background leads into the dance hall. Fire came up the stairway from the lower left and spread down this corridor into the dance hall with lightning-like rapidity, traveling on the flammable decorations with which this space was completely lined.

At one side of the building was a doorway designed to lead to a fire escape. (See Fig. 8.) This fire escape (of a type unsuitable for the present occupancy) had not been installed and at the time of the fire was lying on the ground outside of the building. It is reported that the building department had ordered a rear fire escape installed a year before the fire and that the proprietor of the establishment indicated when applying for a permit to operate the dance hall that he would shortly install a fire escape at the rear of the building. Had a proper fire escape been installed at the rear of the hall it is probable that little or no loss of life would have occurred.

Beside the main entrance to the hall there was a doorway leading to the kitchen. (See Fig. 5.) Stairs from the kitchen led to the lower floor and by this route escape was possible, although the doorway to the outside near the foot of these stairs was securely blocked by means of a heavy wire mesh grille. It was reported that a considerable number of those in the hall at the time the fire started escaped by this route, but there is some question about this, as this kitchen doorway was immediately adjacent to the main doorway and was presumably blocked by flame and smoke filling this entire end of the dance hall at a very early stage in the fire.

Fig. 5. From the front of the dance hall looking down the entrance corridor at the right. This doorway had at one time been protected by fire doors, but these had been removed prior to the fire. It is through this corridor that the fire spread to the dance hall. The door at the left leads into the kitchen. It is reported that some people made their escape in this way, although there is some question about the number, as the flame and smoke coming from the main doorway soon cut off access to the kitchen door.

At the rear of the dance hall there was a small dressing room for entertainers, five feet wide by thirteen feet long. (Fig. 9.) The door to this room was the only doorway at this end of the structure, and in the excitement of the fire was mistaken for an emergency exit. One of the two windows from this room had been closed over, leaving only one window available. This was equipped with a factory-type steel-frame and wired-glass tilting sash, most unsuitably arranged and located as an emergency exit. There was a clear drop of 22 ft. from this window to the brick paved alley below. (See Fig. 10.)

At the time of the fire the night club was in full swing, although as the closing hour, 2 A.M., approached, it is probable that the occupants had already begun to leave. The club was licensed as a dance hall for two hundred and fifty people. No definite statement can be made as to the exact number of occupants in the building at this time, but all reports agree that the number was less than two hundred. Estimates range from seventy-five to one hundred seventy-five, the latter figure being based upon the theory that approximately one hundred may have escaped by way of the kitchen. Owing to the apparent difficulty of escape through the kitchen, the estimate of seventy-five seems more reasonable. In addition to those on the second floor, there were a

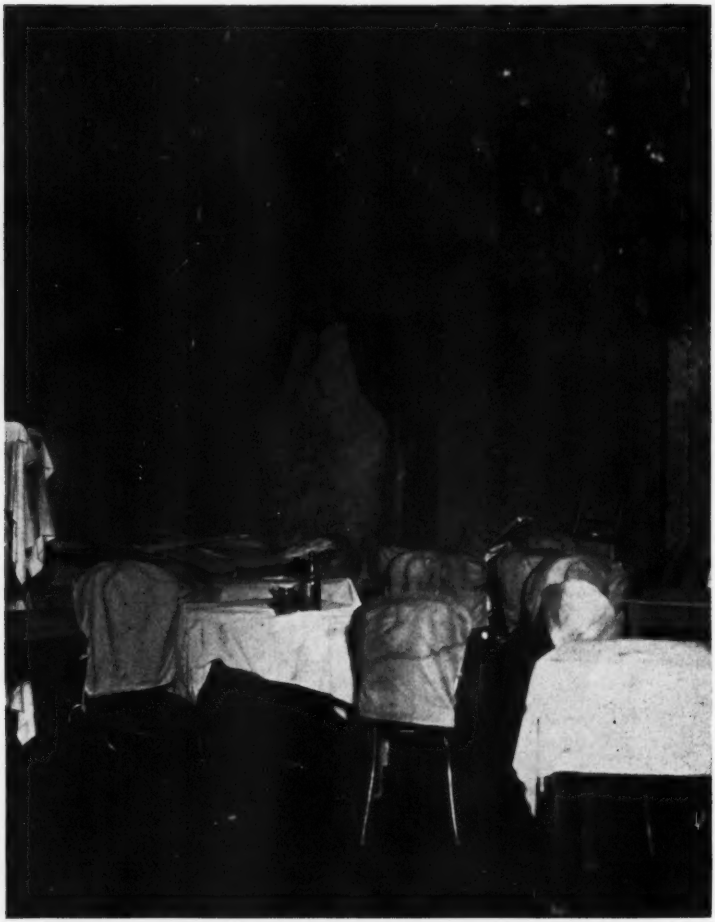


Fig. 6. A portion of the rear of the dance hall which escaped direct attack of the flames owing to more favorable draft conditions and prompt work of the fire department. The ceiling decorations shown consisted of a light wooden lattice and hanging oak leaves, which had been treated with either wax or lacquer. Decorations of this character, including highly flammable cloth draperies (not shown in this picture), covered the entire interior of the hall, corridor and stairway leading to it. The window in the rear is blind, merely a decorative design on the solid plaster.

Fig. 7. This picture shows how the windows were blocked off. Wallboard against the glass, a wooden frame, and the interior finished smooth with plaster board, completely blocked access to the windows and concealed their location. The holes shown here were made by the fire department during fire fighting operations.

number of employees on the first floor, but as these people had no difficulty in making their escape no special attention is given in this report to the first floor occupancy. As is usual in night clubs, it was reported that liquor was in evidence at the tables, but there is no evidence that this contributed in any way to the catastrophe.

Subsequent to the fire, few, if any, people reported to the authorities their presence at the club at the time of or prior to the fire, with the exception of those actually injured. It would accordingly appear either that practically all those present at the time of the fire are accounted for on the casualty lists or that if a number escaped through the kitchen these people are not now willing to admit to the authorities their presence at the club.

Story of the Fire.

At about 1:30 A.M. on Friday, September 20, a man and girl (who have not subsequently been located or identified) were leaving the building. When passing the check room off the first floor hallway adjacent to the entrance, the man spoke to the coat room girl, saying, "Did you know there is a fire back there, girlie?" The girl saw a small fire in a drapery near the foot of the stairway. (See Fig. 3.) The exact point of origin of the fire was at the head of the basement stairway, which had been closed off by a wallboard partition and concealed by the draperies and decorations with which the entrance hall and stairway were completely lined. The girl ran into the first floor kitchen to get water to extinguish the fire. On returning with a pail of water she

Fig. 8. View of the front end of the rear addition, showing the fire escape door. This fire escape, which had not been installed on the building prior to the fire, is shown on the ground under the pile of chairs. One man, and possibly others, escaped by jumping from this point, but sustained injuries.

found that the fire had gained too great headway for her to handle, so she ran from the building calling "Fire." Within a few seconds the chef on duty on the first floor kitchen started to notify the patrons on the second floor, but found that the fire had preceded him up the stairway, so he abandoned his attempt and made his escape from the building. The fire traveled up the stairway through the corridor and into the main dance hall with a lightning-like rapidity. (See Fig. 4.) The powerful draft through this passage induced by the large ventilating fan located above the roof of the dance hall was increased when the front door was left open by employees making their escape from the building. Apparently it was only a matter of seconds from the time the fire was first noted until flame and smoke were belching into the dance hall area.

The exact cause of the fire has not been determined, but the most probable cause would appear to be a carelessly discarded match thrown against the drapery by a patron leaving the building. Much of the electrical equipment in the structure was of an inferior character, but no wiring was located at this particular point, and the wiring is not indicated as a possible cause of the fire.

A club employee was standing in the main room near the door in the direct path of the flame coming through the corridor. The speed of the fire was such that he was impelled to run to the fire escape door at the left of the hall. (See Fig. 8.) This door was locked. The man went through the glass panel and landed in the yard some twenty feet below, breaking both legs. There is no direct evidence that anyone else escaped by this route prior to the arrival of the fire department, when ladders were put up here. It appears unlikely that it would have been possible to reach this doorway and the adjacent windows except during the first few moments, as the fire apparently involved this entire end of the room in a very short space of time.

A double swing door to the second floor kitchen opens from the dance hall immediately adjacent to the main entrance. (See Fig. 5.) It is thought that some of the occupants may have made their escape by this route through

the kitchen, down a service stairway and out of the building, either past the fire through the main entrance or by other routes. According to one estimate as many as one hundred people escaped by this route, but this is very questionable in view of the location of the opening and the very rapid spread of the fire.

Most of the occupants of the hall retreated from the flames towards the rear of the building. The openings through the ceiling which led to the ventilating fan were located near the center of the hall, and in the rear portion the draft conditions were such as to make for somewhat less rapid spread of the fire. In the rear end of the room the decorations were not entirely consumed, but the smoke made the entire area unliveable in a very short space of time. When the lights went out the horror increased.

From the outside of the building numerous windows may be seen around the dance floor area. From the inside, however, these were not visible (with the possible exception of those on the front and which were soon cut off by the fire). They had been covered over with wallboard and plastered so that there was no indication from the interior of any window openings whatsoever. The only opening leading from the rear of the room was a doorway into a small dressing room used by the entertainers, about five feet wide by thirteen feet long. Thinking that this led to a fire escape, the crowd rushed into this space. One of the windows from this room had been blocked off and a few people escaped in this way. The window, factory-type tilting-sash affair, would not be easy for persons to pass through even under normal conditions, and under fire conditions it is surprising that any people escaped in this way. Forty-four inches from this window, adjacent to the corner of the building, is a telephone pole. It is reported that one woman slid down this pole, escaping uninjured except for splinters. One or more others also escaped by this window, dropping some twenty-two feet to the brick paved alley below. Soon, however, a jam occurred and bodies were inextricably wedged together in this small space, making further escape by this route impossible.

Alarm and Fire Department Operations.

The first alarm was transmitted from a street box at 1:32 A.M. There is no indication of any delay in the alarm, which was pulled either by a passing police officer or taxicab driver. The nearest fire station was only a few blocks away and the fire department was at the scene two minutes after the alarm was sounded.

As the fire department drew up to the building the fire was burning briskly in the front part of the structure. No light except that of the fire was visible, and there was no indication that there was anyone inside. The electric light system had been put out of commission early in the fire and the blank windows in the rear portion made it impossible for the fire department to hear

the cries of any of the victims if any were conscious and still calling at the time. The fire department attacked the fire in the usual manner, proceeding in the front entrance and up the main stairway, extinguishing the fire as they went. A line was also taken in the side door on the second floor.

Fig. 9. The dressing room, 4 ft. 11 in. wide x 13 ft. 1 in. long, where thirty-five or more bodies were found by the fire department inextricably wedged together. Several escaped through this window, although below it there is a clear drop of twenty-two feet to a brick paved alley. The window, wired glass in tilting steel sash, would class as a good fire window, but most unsuitable as an exit.

Fig. 10. Rear corner of the building, showing the window from the dressing room. (See Fig. 9.) One woman is said to have escaped by this window and climbed down the telephone pole uninjured except by splinters. Others dropped to the alley.

It was ten minutes or more after their arrival at the building before the fire department reached the rear portion of the dance hall and discovered the bodies there. Fire alarm records show that the second alarm and call for ambulances was received at 1:52 A.M., twenty minutes after the first alarm. The appearance of the building, and the hour of the fire would lead to the natural conclusion that the building was unoccupied at the time, and had it not been for prompt and efficient fire fighting operations the people inside might not have been discovered until much later, with resultant greatly increased loss of life.

When the fire department reached the rear of the dance hall they found some thirty-five or forty bodies wedged into the small dressing room space mentioned above and many others on the floor outside of this room. One girl, buried under a half dozen bodies in the dressing room, retained consciousness throughout. All the others in the building were either dead or unconscious when the fire department reached this portion of the structure.

Loss of Life and Injuries.

Twenty-two persons lost their lives as a result of this fire. Eighteen were dead when removed from the building or died the same day; the others died later in hospitals. There were approximately forty-five cases of reported serious injury. It is assumed, however, that the actual casualty list was larger than this and that any who escaped from the building with minor injuries failed to report them. The deaths and injuries were largely due to suffocation and crushing. Of those killed, half a dozen were seriously burned, the other deaths being due to suffocation. The injuries were divided between burns, suffocation, fractures sustained in jumping from windows, and combinations of these. No complete casualty list is available as this report is written.

The property damage to the building was not heavy, being limited largely to the decorations and trim.

Modern Fire Fighting in Small Cities.

By Frank C. McAuliffe (Member N.F.P.A.),
Chief, Fire Insurance Patrols, Chicago.

Fire chiefs in the smaller cities and towns are of the opinion that the large cities present more difficult problems in fire fighting than those with which they are confronted. That thought is, in my opinion, erroneous as the large city is nothing more or less than a number of small towns. While it is true that each town is not in possession of every type of construction and occupancy, nevertheless, a group of towns, proportionate to the size of a large city, will possess all of the individual fire hazards and fire fighting problems of the large city. The only exception would be that the conflagration hazard, in relation to the exposure of large values, is more pronounced in the large centers of population.

A great many towns have buildings of such a size and nature, together with direct exposure hazards, that one wonders how, in the event of severe fires originating therein, the small complement of apparatus and men available would be able to cope with the situation. So also the same may be said of the hazards to life in the event of fire. A small number of men with inadequate equipment are often called upon to meet emergencies that would tax the efforts of many companies in a large city.

Inspections.

With such conditions in mind, the officers of a small department should make frequent inspections, with the prevention of fires their chief objective and also should acquaint themselves with buildings and methods of attack in the event of fire. They should conduct frequent schools or conferences at which they should plan methods of fighting possible fires in their own towns. They should discuss fire prevention, fire alarm systems, water supplies, salvage and other subjects which are all related to the protection of life and property. In addition, they should arrange with surrounding towns for assistance in case of necessity.

Probably no phase of fire fighting contributes more to a reduction in fire losses and safety of life from the dangers of fire, than systematic inspection and schooling of officers. In addition to the elimination of fire hazards, inspection work and schooling will give officers a knowledge of buildings, occupancies and methods of procedure that may truly be termed the keystone of efficient operations in fire emergencies.

Address before Northwest Fire School, Minneapolis, September 19, 1929.

Drills and Training.

Drills and training are of extreme importance to the small town fire department and light duty companies in a large city. While drills and training are important for heavy duty companies they are, nevertheless, kept in trim and practice by constant duty at fires. Allow a heavy duty company to remain inactive for a short period of time with little or no training and the operations at the first fire of consequence will undoubtedly be bungled by one or more of its members. With all of the improvements in fire fighting equipment, fire duty still demands men who possess a high degree of physical ability. The small amount of actual work performed by the average fireman tends toward his physical disintegration, unless drills and training are arranged systematically and constantly to keep him physically fit. A combination of inactivity, corned beef and cabbage, and occasional severe physical strains have killed more firemen than falling walls.

Good Men and Modern Equipment.

The two most important requisites of fire fighting, in either the large city or small town, are good men and modern equipment. A poorly paid fire department is false economy, as it is as difficult to hire a $2000 a year man for $1000 as it is to purchase a $10.00 pair of shoes for $5.00.

In the selection of equipment thought must be given to the actual needs of the community. It is not economical or practical to purchase an 85-foot aerial ladder truck merely because several buildings exist in the community where such a truck could be used to advantage. Nor would it be practical to purchase a foam engine for the protection of a few scattered oil risks; nor a water tower because of similar reasons. The practical and economical procedure would be to have private equipment provided at those properties to compensate for the lack of fire department apparatus, such as ample fire escape facilities or enclosed stairhalls in the few scattered buildings which would be inaccessible to a ladder truck of a size necessary for the town's general needs. The oil properties should be protected with private fire protection devices and sprinklers installed in dangerous conflagration breeders. In general those buildings which, in the event of fire, would be difficult to handle efficiently with the available equipment, should be privately protected.

When purchasing a pumper several features are of importance. In the early days of motor apparatus a 1000-gallon pumper was heavy and difficult to handle. Today a 1000-gallon pumper is practically the same as a 750-gallon pumper. It costs very little additional and is just as mobile. A 1000-gallon pumper for a one company fire department, in a town where roads permit, is more desirable than in a city where several pumpers are available. Perhaps the water supply will not furnish a 1000-gallon delivery, but the fact remains that many buildings in towns of that nature are a long distance from the water supply. In such cases, the additional power may be used to furnish

the pressure necessary on long leads. The fire department contemplating the installation of a pumper should carefully consider the conditions and purchase reserve power for possible exigencies.

Auxiliary Equipment.

Frequently towns purchase expensive pumpers and the auxiliary equipment is neglected. No town would purchase a ladder truck and furnish one or two ladders. Nevertheless, pumpers are often found with minor equipment consisting solely of hose, two or three battered nozzles of inconceivable sizes, and the inevitable bell and siren. The body, of course, is flashily painted with red and gold, one of the features never overlooked. Such an apparatus is best described as "all front and no back."

Small fire departments should be provided with substantially the same equipment as that carried in the large cities. They should carry more hose on their apparatus than the larger departments in order to compensate, in a measure, for the hose that would be available when several companies respond.

The officers should have a knowledge of hydraulics and should understand how to obtain results from their pumpers under the varied conditions encountered at fires.

The booster pump has been a boon to the small fire department and should be given consideration, especially when purchasing new apparatus or replacing chemical tanks.

The Size of Hose.

A very large percentage of fires in any city can be handled with $1\frac{1}{2}$-in. hose lines, and in small towns, where the complement of officers and men is small, that type of fire fighting should be encouraged and a high degree of efficiency should be attained.

It is problematical whether 3-in. hose should be used in the small department. Fires at which its use would be advantageous would rarely occur and the space necessary for 3-in. hose could be used to a better advantage by additional lengths of $2\frac{1}{2}$-in. hose. Where a heavy stream is required and the 3-in. hose would be desirable, the use of the siamese and the extra length carried would reduce the frictional resistance proportionately.

The differences of opinion, regarding the use of hand pumps *versus* chemical extinguishers by fire departments cannot be covered in detail here. However, hand pumps are gaining in favor throughout the country and the use of good substantial hand pumps, that receive daily inspection, will be found advantageous for small departments.

When purchasing a pumper for the small town care should be taken to utilize all available body space for boxes and compartments to carry the numerous tools and appliances that are carried by the larger departments on several types of apparatus. The use of the same type of body construction for all cities is a common error. Tools and equipment, carefully and systematically arranged, add to the efficiency of fire operations.

As previously stated, every town has certain supporting industries and institutions which present special fire problems. The large number of special hazards and precautions to be taken to prevent or extinguish fires in such risks would require volumes to describe and only a comparatively few of the special hazards would be of interest to the individual towns. Every Fire Chief should study the special hazards which exist within his province and specialize in modern methods of operation in fire prevention, control and extinguishment as applied to his particular problems.

Fires in residential and small store properties are common to every city or town, and as the large majority of fires occur in such risks, a brief explanation of some of the modern methods of operation being used in such cases may be of interest.

The firemen of our country are so imbued with the spirit of competition and speed that serious accidents have occurred almost daily since the motorization of fire departments. The fire officer who makes certain of an alarm location and proceeds with safe and sane driving will arrive with a company prepared for action. The excitement incident to dangerous speed will be lacking and the officer will be in a state of mind to plan his attack in a cool and deliberate manner and his men will carry out their orders similarly. "Haste makes waste" is a saying that should be posted on every fire department bulletin board in the country.

Handling Residence Fires.

Upon arrival of a company at the ordinary residential fire the officer in charge should use care in forcing entrance if that is necessary. Many a valuable entrance door has been ruthlessly demolished to save a pan of food burning on a stove. The extent of the fire should determine the method of operation. The majority of residential fires can be extinguished by hand pumps or extinguishers and in only occasional cases would it be necessary to use anything larger than a $1\frac{1}{2}$-in. line. The fire officer should appreciate that inside operation of hose lines is most desirable and that he may as well allow the building to burn to the ground as to wash it from its foundations.

If it is hot and smoky and impossible to advance upon a fire to a position where fire can be seen, the officer in charge should not allow the pipe to be opened. He should have the building ventilated by lowering the windows from the top and raising them from the bottom. If the fire has extended to or originated in an attic space and it is impossible to advance the line into that space, the roof should be opened directly over the fire to allow the heat and gases to rise and allow the line to be advanced.

Ventilation.

Unnecessary ventilation is generally unnecessary destruction, and roofs should not be opened or windows broken unless that procedure is necessary.

When it is necessary to open a roof a clean cut square hole of sufficient size should be made in preference to chopping out several small holes. Repairs can then be made more easily and temporary protection from the elements is a more simple matter. Good axmen and good axes are an important feature in ventilating fires and axmanship should be developed to a high degree of perfection in all departments.

Fire officers should take a pride in their work and handle a residential fire, with its often irreplaceable family possessions, as he would a fire in his own home. If he has a fire in concealed spaces it is not necessary to pull pictures to the floor, trample on draperies, destroy lighting fixtures, pull plaster down upon the rugs and furniture and in general wreck havoc upon the building and contents. Feeling the walls and by the heat determining the location of the fire, picking up the rugs, carefully removing or covering the furniture and opening the walls or ceiling in a sensible manner, are marks of good fire fighting.

In the event of an attic or upper floor residential fire where it is necessary to use a fire stream, one or two men can usually be spared, particularly after the line is stretched and water is available. These men should go below, remove all clothing from clothes closets, rugs, curtains, draperies and pictures that may be subjected to water damage; place them on beds and furniture which in turn should be brought together and covered with a salvage cover. Such work should be started immediately under the fire and extended to other rooms as the need requires.

After the fire the floors should be squeegeed to prevent warping. Debris should be gathered together, and plaster, laths and such other waste material should be thrown out. Partially burned furnishings should be placed in a salvage cover for possible salvage.

Fire officers should have a knowledge of modern methods of temporary roof protection, and if holes exist they should receive the proper attention.

In extremely cold weather an effort should be made to maintain heat and prevent loss to plumbing and heating fixtures. If that procedure is impossible all pipes, fixtures and tanks should be drained. Every possible effort should be made to make the premises livable for its occupants, as such work will give firemen the good will of the citizens they serve and ultimately redound to their benefit.

Store Fires.

Assuming the usual small store with an apartment above, the method of operation depends largely upon the location and extent of the fire. If the building is heavily charged with heat and smoke, no time should be lost in forcing entrance. It is presumed that men are sent to the apartment to assure the safety of the occupants and to ventilate. Breaking the glass panel in the entrance door under those conditions is advisable. Attempting to force heavy

entrance doors by other means usually results in broken door frames and fittings with the glass panels cracked or broken in the final analysis.

An effort must then be made to locate the fire. In the event that the heat and smoke make that impossible, further ventilation must be made. The transom over the door can be lowered or broken and men sent to the rear to break a window or force a door.

Should the fire have originated in the basement and extended so as to make it impossible to advance a line down the stairway, immediate steps must be taken to ventilate the basement. Basement windows, coal hole covers and deadlights are common means of basement ventilation. Sufficient first floor ventilation must also be made to permit men to stay on the floor and to prevent communications through vertical openings and concealed spaces. If it is necessary to break plate glass windows it may be possible to remove the contents of the show window before that work is done. Show window partitions should, in that case, be removed or opened to permit unobstructed ventilation.

A hole should be made directly over the fire and a distributing nozzle or a basement pipe inserted. Efforts should be continually made to advance a line down the stairway, deadlights, windows or other entrances and, as soon as that procedure is possible the basement pipe or distributing nozzle should be shut down and the company or companies advanced upon the fire. Careful use of water on the first floor is essential to prevent unnecessary loss to the contents.

Officers must determine the floor load, type of floor construction and intensity of the fire, in order to guard their men against the collapse of the first floor. Broken deadlights and holes cut in the floor should be obstructed to prevent men from walking into them.

Frequently broken gas lines in basements burn fiercely after most of the fire has been extinguished and officers should be careful not to extinguish the flame with the streams until ready to shut off at the meters or plug the openings. Escaping gas is considerably more dangerous in such places than a free burning flame.

Basement drainage should be given attention, as the water may extend into adjoining buildings and damage basement stocks. Placing a siphon in the basement, using a pumper direct or breaking soil pipes are common methods of procedure.

When overhauling, care should be used to prevent additional damage and all possible assistance should be given the owner to prevent additional loss by rain, snow or extremely cold weather.

Investigation of Fires.

One of the points frequently overlooked is a careful investigation of the fire to determine the cause and to obtain such other information as may be required for a complete and intelligent report to the State Fire Marshal or other coöperating departments and agencies.

Information gathered at the time of a fire is always of vital importance should the fire prove to be of incendiary origin. In any event, a city or town with authentic fire records is in a position to direct its fire prevention activities in the proper channels with a high degree of efficiency.

The small town Chief must realize his responsibilities and be constantly on the alert for the ever present enemy, who will eventually steal upon his forces, when he least expects. He must be prepared to defeat that enemy with the superior forces of foresight and stratagem.

Dwelling House Inspections.

By Daniel B. Tierney,
Chief, Fire Department, Arlington, Mass. (Member N.F.P.A.).

The old maxim, "An ounce of prevention is worth a pound of cure," has never been improved upon, and the full force of its meaning is just now dawning upon us. Every phase of business and professional life today is achieving success through practice of preventive measures—prevention of waste, prevention of lost time, prevention of fire and the elimination of losses therefrom.

In no line of endeavor are prevention efforts receiving greater consideration than in the profession of fire fighting, where fire extinction and fire prevention are so closely allied that the efficiency of a department can be measured by the attention given to fire prevention.

The exact amount of good resulting from fire prevention activities is difficult to compute, but every fire chief knows that the number of careless fires in property under constant and systematic inspection is less and the losses smaller. In 628 places inspected twice each month last year by our department we had 18 fires (two of these were incendiary), with an average loss of $877. With such a record it is only fair to assume that "putting them out before they start" is real and successful.

It is generally admitted that public buildings, factories, mercantile establishments and other business buildings should be inspected, and they are, as often as the head of the fire department deems necessary or in proportion to the number of men available for the work.

These inspections, while primarily for the purpose of eliminating fire hazards, also afford an excellent opportunity for the men to learn the interior of the buildings, the type of occupancy, location of vertical and horizontal openings, partitions and fire walls, sprinkler valves, etc., all of which is valuable knowledge when fire occurs in such property. Different firemen should be sent on each inspection in order that all will have a knowledge of the general layout of each building in the city or district, and incidentally this practice will make for a more thorough inspection, as a hazard overlooked by one will be discovered by another.

Every fireman after a little experience will be able to draw a rough diagram and indicate the location of any part of the building for which information is desired, and a simple report form covering all details will enable him to make a systematic report of conditions found.

It has always been an indoor sport of firemen to fight each fire over and over again, checking up the mistakes made and discussing the proper method of handling them. A thorough knowledge of buildings obtained through inspection eliminates a lot of snap judgment and makes the attack on fires more effectual.

To confine fire prevention work to public and business properties alone, in my opinion, is not sufficient. Residential inspection annually is most important and necessary. "Facts About Fire," published by the National Fire Protection Association, states that over 60% of the number of fires take place in homes, and 66% of the deaths and 40% of the injuries by fire occur in dwellings.

In the State of Massachusetts, in 1928, a total of 8541 fires with loss were reported to the State Fire Marshal and of this, 4320, or 50.6%, were for dwelling house property, exclusive of such occupancies as rooming houses, apartments, stores and dwellings combined, and summer camps. The total loss in dwelling house property for 1928 was $5,248,726, representing 34.2% of the entire loss for the state and being an average loss per fire of approximately $1210, a fairly high figure.

When a chief considers residential inspections he is confronted with the question of his right to do so, for "a man's house is his castle." The laws of Massachusetts provide that "The Fire Marshal, or any one designated by him, may enter at any reasonable hour any building or other premises, or any ship or vessel to make inspection or to enforce any law, ordinance or by-law, or any rule or order of the Fire Marshal without being deemed guilty of trespass, provided that there is reason to suspect the existence of circumstances dangerous to the public safety as a fire menace."

While there may be reason to suspect the existence of circumstances dangerous to the public safety where the occupants are unaware of what might constitute a fire hazard, there is absolutely no need to invoke the law during a general inspection. Last year was our fifth annual inspection. We visited 5924 homes and were refused admission to only six.

How can the people be approached and their co-operation obtained? One means is by a notice in the local paper, or, better still, an editorial on the proposed inspection. Such an editorial might bring out the fact that cellar fires in dwellings, especially when they occur in the night, are most dangerous and often cause loss of life; that they are easier to prevent than extinguish. It should also be pointed out that practically every fire in the home is due to carelessness in allowing breeding places for fire to exist, such as rubbish,

TOWN OF ARLINGTON, MASSACHUSETTS
Fire Department

Fire Department
Monument Park **Daniel B. Tierney, Chief**

The Sixth Annual Inspection by this department will begin Monday, September 30, 1929, and continue until the cellars of approximately 6200 dwellings have been thoroughly inspected by firemen who are "off-duty."

All unsafe conditions liable to cause fire or its spread will be brought to the attention of the occupants and advice given for their correction.

Sixty per cent of all fires and 66% of all deaths from fire occur in dwellings; the victims are usually women and children.

Cellar fires are most dangerous, especially when they occur in the night, and often cause loss of life. They are easier to prevent than extinguish, and are always caused by carelessness in allowing breeding places for fires to exist.

The principal contributory causes are rubbish, papers, oily rags, ashes in wooden containers or against wooden partitions, defective pipes and chimneys, electric wires resting on iron pipes or held in place by nails and iron staples.

In nearly all of the two-apartment houses the cellars are divided by a wooden partition that often extends to the ceiling. This constitutes a severe hazard. The boards, being thoroughly dry, are easily ignited by hot coals when ashes are thrown against them or when the space through which the pipe from the heater enters the chimney is not sufficiently large.

Such partitions are convenient places for hooks and shelves on which to place paint pots and other highly inflammable materials which add to the danger. For personal safety these should be removed and wire partitions substituted. A better lighted and ventilated cellar as well as increased safety will repay the small cost.

A tap from the water pipe for a faucet to which the garden hose is attached for emergency during the winter months would be an additional factor of safety.

That the residents of the town more fully realize the danger to life from cellar fires is clearly shown by the fact that hazards found in 5924 homes inspected in 1928 were many less than in 1924, when 3918 houses were inspected.

Twenty-three per cent of the deaths from fire are from improper use of flammable liquids. These should never be used in the home for cleansing purposes or to start or accelerate fires in stoves and heaters. Continual use of these liquids oftentimes provides a false sense of security. There can be no assurance that it will always be a safe practice; when the inevitable flash occurs it will be swift and probably fatal.

The attic, the catch-all for "things that may be needed sometime," should claim the attention of the householders. Fires that originate there cause as much damage to property as cellar fires, but the life hazard is much less.

papers, oily rags, ashes in wooden containers or against wooden partitions, defective pipes and flues, pipes too close to wooden partitions, electric wires resting on iron pipes or held in place by nails and iron staples, and the use of improper fuses. These are the principal contributory causes of fire, and it is explained that the firemen will merely look through the cellar for these conditions and will advise as to their correction.

When people realize that this is solely for their benefit and protection, they will not only co-operate, but will welcome the inspection.

In the fall, when fires are being started in the heaters, is the ideal time to inspect. October 9th is the anniversary of the great Chicago fire, and the President of the United States by proclamation, and the governors of each state proclaim in like manner the week in which this date occurs as National Fire Prevention Week—a most opportune time for general inspections.

We are urged during this week to bring to the attention of the people the tremendous loss of life and property by fires. How better can it be done than by offering our services to help them safeguard their lives and property?

Different methods are employed, such as talks to school children and citizen groups, radio broadcasts, parades and spectacular displays. All these, no doubt, have merit, but in my opinion their principal value is that they awaken an interest in the minds of the people, making readily acceptable a practical personal inspection as outlined above.

How can the inspection be accomplished with a small force of men? This question bothered me before our first one in 1924. I thoroughly believed in it, primarily as a medium of acquainting the people with potential hazards existing in cellars that might cause loss of life. In many places, though hazards were plenty, they had never had a fire and felt immune. I also realized that two men were necessary for each inspection to obviate the possibility of any unpleasant occurrence that might spoil the inspection and embarrass the department.

The men were consulted regarding the matter and readily agreed to volunteer their services on "off-duty periods" for the week. The importance of this sacrifice on the part of the men was stressed in the notices announcing the inspection.

Two men call at each house, state their errand and invite the occupant (generally the housewife) to accompany them while they check up the hazards, explain the danger of each and advise their correction.

Very frequently she is amazed to learn that something regarded as harmless may, under favorable conditions, start a fire, and immediately resolves that male members of the family will get busy in the cellar before they retire for the night. And why shouldn't they? They use the utmost precaution to place their valuable papers and documents in a fireproof vault; surely at least as much care should be taken to make the cellar, over which all who are near

and dear to them live, as near fireproof as possible. In event that a community does not make regular collection of rubbish, it is certain that they will co-operate to the extent of removing whatever is placed outside during the inspection

The good effect of these inspections in the fire department itself is apparent in many ways. It will inspire public confidence in the firemen and establish a sound appreciation of their value to the community, where before, in some cases, they were considered a burdensome overhead expense.

It will awaken interest in the welfare of the department, and requests for increases of salary and better living conditions will not go unheeded, and the chief's requests for additional men, the abolition of the dangerous wooden shingle, new equipment, adequate building and fire prevention laws, and other improvements for fire safety will have more weight because he has shown clearly that his only interest is the safety of the community.

This activity need not be confined to permanent men. Call men and volunteer firemen may do the same. It is a well-known fact that these men are often the best type of firemen, because they love the work and are always ready and willing to sacrifice and serve for little or no salary.

There is no department in a community more important and less known than the fire department, often in the background until a fire occurs. The citizens insist that their public schools be sufficient and standard, that the police service be adequate, streets passable and safe, water and health departments able to care for personal needs and comfort. All of these are daily necessities, the support of which is seldom questioned and rarely opposed, because they know all about them. They are continually served by them.

Relatively few people outside of city or town officials have intimate knowledge of the fire department. They know where the stations are, that in case of fire they may pull a box, and censure the department for being slow, and otherwise criticize the firemen. They own the stations and equipment, though they rarely visit them and for that reason do not know that there is a class of municipal employees that take the best of care of the property entrusted to them.

They pay the firemen's wages but do not know what type of men are serving the community. They are not informed whether the firemen earn what they get or if they deserve more, but are quite sure that their occupation between fires is wearing out trouser and chair seats. In their own businesses they would know these things, and as taxpayers they should interest themselves in the daily activities of the department.

The time has come when fire departments must of themselves bring to the public mind the value of the service which they render the community. In no way can this be more effectively done than by inspection—particularly residential inspections.

A Survey of Farm Fires.

A survey of farm fires and rural fire protection was made during the past summer by Mr. George D. Mock, Field Engineer, N.F.P.A., under the direction of the Committee on Farm Fire Protection, Mr. David J. Price, chairman. Mr. Mock visited typical areas in the Middle West, South, and East having high and low fire loss ratios, and studied rural fire departments in the several sections. The following is extracted from Mr. Mock's report to the N.F.P.A. Committee on Farm Fire Protection, at its meeting in Chicago, September 23 and 24, 1929.

The territory covered included sections of Iowa, Ohio, Michigan, Indiana, Illinois, Kentucky, Tennessee, and Maryland. It is felt that the amount of time devoted to this study was wholly inadequate, and that much more time might well have been devoted to the data already collected. It is hoped, however, that the information obtained will be of value in further work in this field.

The general plan contemplated a study of the following items:

I. Various localities with special attention to structural conditions and other factors which might contribute to farm fire losses; and to fire statistics when available.

II. Rural fire protection.

III. Rural fire prevention.

IV. Existing agencies which might be used to further fire protection and prevention on farms.

1. General Upkeep of Farms.

In northeastern and central Iowa the upkeep of farms was generally good. This may be attributed to the fact that much diversified farming is done in this section. From the central to southern section of Iowa farms did not appear to receive quite the attention which they did in the northern part of the state.

In northeastern Indiana, southeastern Michigan, and northwestern Ohio farms were generally well maintained. Buildings were painted, though fences were not in such good repair.

Central Indiana and eastern Illinois showed a rather marked effect of the recent farm depreciation. Buildings often showed a lack of paint and in many cases chimneys had been neglected. This section could, however, be classed as generally good.

Southern Illinois, central Kentucky and central Tennessee could be placed in the same category. Much laxity in housekeeping was in evidence.

Paul W. Savage.

Three fire departments were helpless at this fire because of a total lack of water. The fire started in the barn, due to spontaneous ignition of hay, and quickly spread to the near-by house.

In the blue grass country of Kentucky and in southern Indiana, with the exception of Warrick and Vanderburg Counties, farms were generally well kept.

On the eastern shore of Maryland farm buildings were in fair condition, due somewhat to the fact that much truck gardening is done besides the raising of grains and cattle, and to the fact that this section is becoming very rapidly a summer resort.

The fact that farmers have gone through financial hardships during the past few years is quite noticeable generally in the appearance of buildings and fences.

2. General Construction.

Where farm valuations are high, generally the construction of buildings and maintenance is good. There are, of course, exceptions to this statement in any locality.

HOUSES: In Iowa, Illinois, Indiana, Ohio, Maryland, and in the blue grass country of Kentucky houses were generally well constructed and were of average size. In southern Illinois, western and central Tennessee, and in central Kentucky houses were very small and had corresponding low valuations.

BARNS: For the area in which large houses were in evidence large barns were also. In western Kentucky, Indiana, Tennessee, and in southern Illinois barns were of flimsy construction and of very low value.

CHIMNEYS: Central Kentucky and Tennessee were the only areas in which brick-on-edge chimneys were noted. In Iowa the use of iron flues on kitchens and summer kitchens was quite frequent. The best area for well-constructed chimneys was in northeastern Indiana, northwestern Ohio and part of southern Michigan.

ROOFS: Generally speaking, except in Ohio and Michigan and parts of the blue grass region of Kentucky, where fire-resistive roofs were used to some extent, most roofs were of wood shingles and clapboards.

3. Lightning Protection.

Through northern Iowa and Ohio and southern Michigan lightning protection was generally noted. The area in northeastern Indiana, southeastern Michigan and northwestern Ohio appeared to be the best protected of any visited. In this section rods and grounded metal roofs are used extensively. In the remaining areas visited very little protection was in evidence, except in central and southern Indiana and central Illinois.

It is not common practice for farmers to ground wire fences which enclose pastures. But few of this type were noticed. During the course of the study only one instance was reported where lightning had followed telephone wires into a house and caused a fire. This was in Winneshiek County, Iowa. Records of fires from this cause are not available.

In those states in which lightning protection was most used it was noticed that hay fork rails were also grounded either to the lightning rods or to a metal roof. Some losses from lightning have occurred when manure carriers and stanchions have not been grounded.

4. Cause of Fires.

There is no mystery about farm fires. From a study of records it appears there are really three causes to which the major part of farm losses can be attributed, namely, defective flues and heating appliances, lightning, and sparks on non fire-resistive roofs. Of course, the spontaneous ignition of hay, careless use of matches and smoking, and the careless use and storage of flammables are also major causes. Unfortunately, stills have caused quite a few fires. In some cases defective electric installations have caused fires, but this is not such a common occurrence, due to the fact that electric service for farms is still in its infancy and that many insurance companies require that the installations be made according to the National Electrical Code before they will accept the risk.

Through the courtesy of Mr. Earl H. Myer of the Farmers Mutual Insurance Company of Indiana, we obtained his report on various risks which his company carries and which he inspected in 1926 and 1927. Quoting from this:

> Of the 2237 places inspected there were found to be 602 defective flues, 635 old shingle roofs, 84 defective rods, 115 places where gasoline was stored in buildings, and 18 miscellaneous defects, making a total of 1474 fire hazards, or more than one fire hazard for every two places inspected.
>
> Of the 192 places reinspected, 76 flues had been repaired, 30 roofs replaced, 16 rods repaired, six gasoline tanks removed, four miscellaneous, making a total of 122 hazards removed.

These two paragraphs give a very good conception of the class of hazards to be found on most farms.

A further study of this report shows that sparks on roofs of dwellings, over a period of three years, contributed the greatest loss and also the largest number of fires. Lightning was second, and defective flues third.

It is the practice of some farmers to build large barns and thus to place their property largely under one roof. This no doubt facilitates working in the barn to a great extent, but from the fire hazard viewpoint this is not the best practice. Unless the farmer can build a fire-resistive barn properly fire-stopped, which in most cases is a financial impossibility, he is faced with two alternatives, (1) to place all his farm material and products in one combustible building, or (2) to place them in separate buildings arranged to accommodate each phase of his farm work.

Quite a few fires have occurred in hog and brooder houses. Iowa was the only state in which we have data for these various occupancies. For the last

Hugh E. O'Donnell.

After saving some furniture, all the neighbors could do was to stand by and watch this farm home burn.

ten years over 500 fires have occurred in brooders, incubators and chicken houses, with at least 70% of these fires occurring within the last five years. During the ten years 95 hog houses burned, but these fires seem to occur rather evenly over the entire period of time. In most cases fires in these types of buildings were caused by improper installation of heating appliances, though in a few cases losses were suffered from exposure when larger farm buildings burned.

A very interesting cause of fires in Kentucky and Tennessee is the firing of tobacco in barns. In those sections where black tobacco is grown it is necessary after the tobacco has sweat several times in the barn to dry it. Drying is done by digging a trench in the center of the barn and building a log fire in the trench. This practice is rather hazardous; at least many fires have occurred where this process has been used. Some feel that it invites much carelessness, especially when the price of tobacco is low and the crop is insured heavily. In this case the major part of the loss is not from the burning of the building as much as the contents—tobacco.

5. Fire Losses.

The annual farm fire loss in this country is estimated at $100,000,000 by the N.F.P.A. Committee on Farm Fire Protection, and the figure $150,000,000 is given for farm and small rural community losses combined.

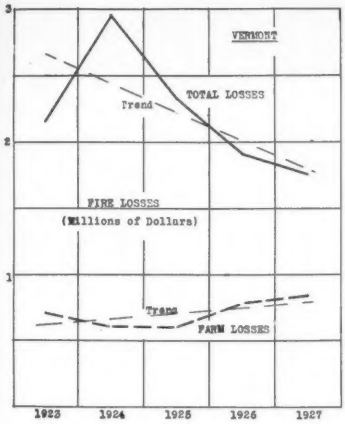
In this study total state fire losses and farm losses are analyzed for eight states. These states are fairly well distributed throughout the country. The accompanying table summarizes these data.

Fire Losses.

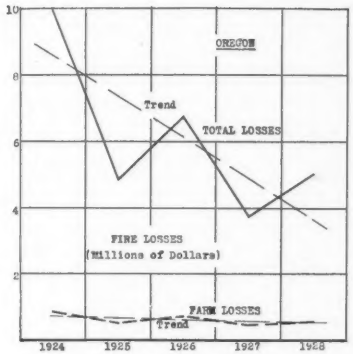
State of Wisconsin:		1926	1927
Total State Loss		$6,704,332	$8,350,937
Farm Loss		2,734,210	2,682,090
% Farm Loss to Total		40.8%	32.2%
State of North Carolina:	1926	1927	1928
Total State Loss	$6,649,152	$5,744,077	$4,912,925
Rural Loss*	1,654,742	1,126,168	1,207,476
% Rural Loss to Total	24.8%	19.5%	24.1%
State of Michigan:			1928
Total State Loss			$13,064,342
Farm Loss			1,407,478
% Farm Loss to Total			10.7%
State of Oklahoma:			1928
Farm Loss			$759,721
State of Iowa:		Aver. Last 10 Yrs.	1928
Total State Loss		$8,484,480	$6,141,522
Farm Loss		2,188,221	2,149,484
% Farm Loss to Total		25.8%	35.0%
State of Oregon:		Aver. Last 5 Yrs.	1928
Total State Loss		$6,067,793	$5,037,944
Farm Loss		632,853	583,255
% Farm Loss to Total		10.4%	11.6%
State of Vermont:		Aver. '23-'27 Incl.	1927
Total State Loss		$2,218,808	$1,757,055
Farm Loss		709,775	841,780
% Farm Loss to Total		32.1%	47.9%
State of Indiana:		1927	1928
Total State Loss		$6,874,263	$5,039,105
Rural Loss**		2,628,074	1,559,198
% Rural Loss to Total		38.2%	30.0%

Last year the fire loss, according to the National Board of Fire Underwriters, was decreased $6,000,000. From a study of various state reports it can be seen that the losses in cities of 20,000 or over are on a decline and that those between 10,000 and 20,000 are remaining practically the same. Farm losses have been relatively stationary, though in some cases they have shown a slight increase. The accompanying charts for Iowa, Vermont and Oregon show the general trend of the state losses and also the farm losses.

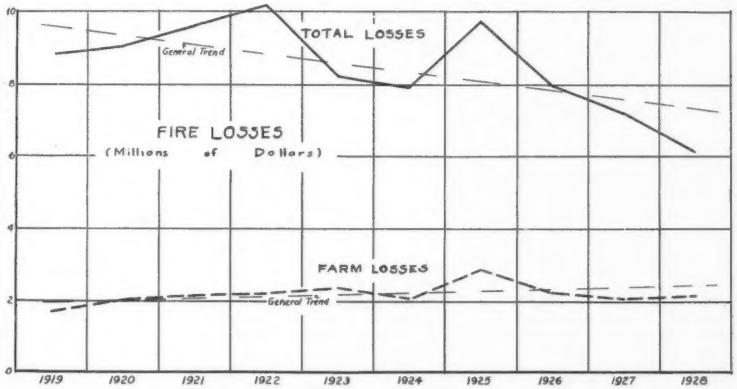
*Under 2500 population. **Under 5000 population.



Fire Losses—Vermont.

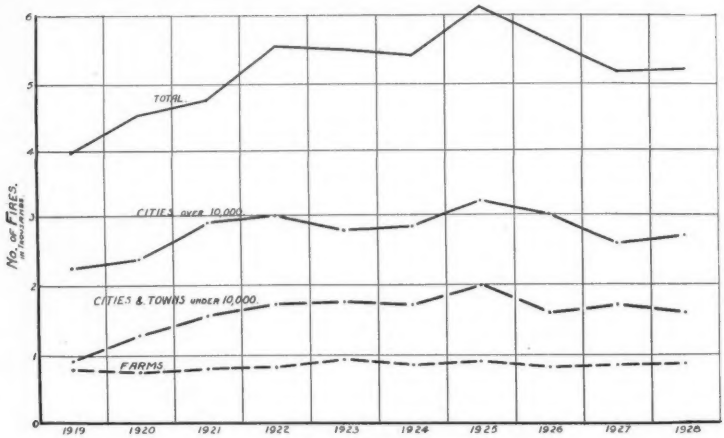


Fire Losses—Oregon.



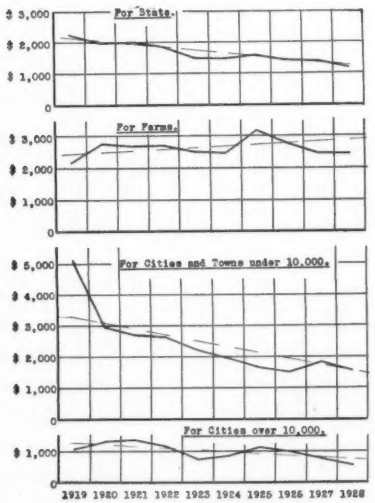
Fire Losses—Iowa.

In the major farming states the greatest proportion of the fire loss appears to be carried by the small cities of 5000 to 10,000 and under, and by the farms. Iowa was selected for detailed analysis as a typical farming state for which figures were conveniently available. Figures for Iowa show that roughly one-third of the fire loss is carried by cities over 10,000 and that 50% of the number of fires occur in these cities; that 40% of the losses and 30% of the fires are in cities and towns under 10,000; and that an average of 25% of the losses and 20% of the fires are on farms. The accompanying chart of average loss per fire in Iowa shows that the average loss per fire is

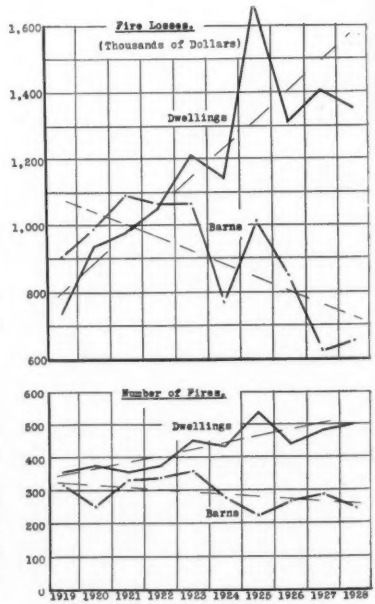


Number of Fires—Iowa.

CHARTS OF IOWA FIRE STATISTICS.


For State.
For Farms.
For Cities and Towns under 10,000.
For Cities over 10,000.
1919 1920 1921 1922 1923 1924 1925 1926 1927 1928

Average Loss per Fire—Iowa.



Farm Dwellings and Barns—Iowa.

lowest in large cities and highest on farms over a ten-year period. A very interesting fact is that the average loss per fire in cities over 10,000 is lower for the last five years than for the first; similarly for cities and towns under 10,000, but for farms it is higher. These average loss-per-fire figures may not seem to be reliable in making comparisons, due to the fact that the larger cities have a greater number of fires. However, there is the consideration that for every fire in a city there is a greater potential possibility of a larger loss occurring.

The average loss-per-fire figures are a rough index of fire protection. They also show that the number of fires occurring on farms have remained about the same, whereas for the other two divisions they have increased and the losses have increased, though not at the same proportionate rate.

The seeming lack of great fluctuation in the number of farm fires led to an analysis of the number of fires in houses and barns (see chart), because these two occupancies contribute 95% of Iowa's farm fire losses. The general decrease of the number of barn fires is offset by the increase in the number of dwelling fires. No reason for this has been advanced. Not only is the number of fires increasing annually in farm dwellings, but also the average loss per fire. The opposite of this is true for barns.

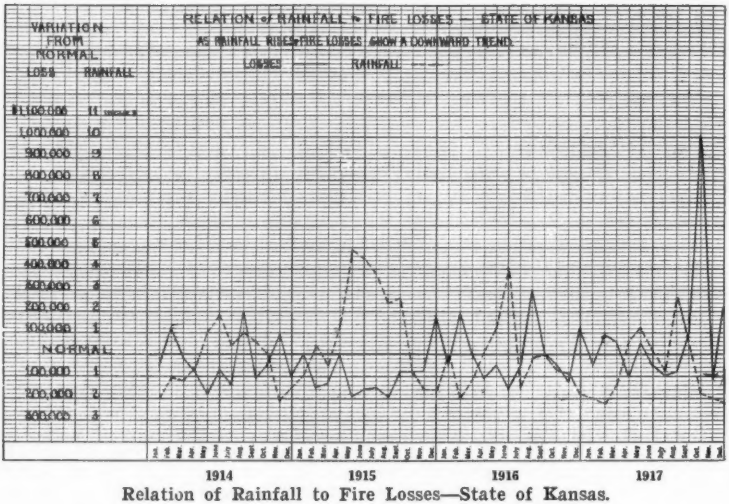
In order to arrive at an annual loss figure for farms we wished to learn what percentage of the fires on farms were total loss fires. Unfortunately Iowa was the only state which had data for this. From the years 1918-1923 inclusive for barns 96% of the fires in this type of occupancy were total loss fires. For dwellings for the same period of time 76% were total loss fires. It would be interesting to make a comparison of this experience with that of some state which has a goodly number of rural fire departments to ascertain exactly the effectiveness of these departments.

Three Typical Counties in Iowa.

Statistics on three counties in Iowa were obtained from Fire Marshal John W. Strohm, which may be summarized as follows:

Lucas County, located in the central-southern part of Iowa, had 119 fires in five years with a total loss of over $200,000, of which 36% occurred on farms. If, however, one mercantile fire of over $64,000 were deducted from the town loss the farm loss would be over half the total. The average loss per fire in the towns of this county was less than $1500, whereas those in the country average $3000. In this county defective heating appliances in farm dwellings caused the major loss in that class, followed closely by sparks on wooden roofs. No case occurred where lightning caused a fire in a dwelling.

The experience in O'Brien County, located in the northwestern part of the state, was similar to that in Lucas.



Relation of Rainfall to Fire Losses—State of Kansas.

Winneshiek, a northeastern county, had greater total losses and the greatest number of fires was from sparks on wooden roofs.

A combined study of these three counties by months for a period of five years was made. During the months of May to August the greatest number of barns were burned, whereas from January to April the greatest number of dwellings burned. On the basis of the available information it would appear that at least 50% of the fires in the country section occur when the roads are open. This study was made primarily to find out in how far it would be feasible to promote rural fire departments in Iowa even where the majority of country roads are unimproved.

The condition of the ordinary country roads depends a great deal upon the amount of precipitation at different times of the year. Not only is this true for the condition of the roads, but also for the fire losses.

Data on the relation of fire losses to rainfall in the state of Kansas from 1914-1917 show not only that the fire loss but that the number of fires is in inverse relation to the amount of precipitation. No similar comparison for a more recent period has been made, but it is felt that current figures would show no different relation.

Even though the fire experience of but eight states out of forty-eight is presented, it indicates that the need of fire prevention and protection is acute for farms and rural communities. The need of private fire protection is especially urgent on farms.

6. Fire Protection on Farms.

In all the farms and rural areas visited it was noticed that very little fire fighting equipment, generally none, was available. In Winneshiek County, Iowa, one farmer had constructed a large reservoir with a capacity of 80,000 gallons on the top of a hill overlooking the farm buildings. This system, with a head of 85 ft., enables the farmer to play a stream of water over the roof of the house and barn. In Kentucky and Maryland the use of standpipes and placing of tanks on windmill structures was noticed. There was general lack of fire extinguishers or fire buckets on farms and also ladders which should be easily available in time of fire.

Rural Fire Protection.

ROADS: The roads in Ohio, southern Michigan, Indiana, Illinois and in the blue grass country, with the exception of the southern parts of Illinois, Indiana and Ohio, are generally well improved, including side roads. In Maryland the main roads were in good condition, but side roads were usually plain earth. Iowa, central and western Kentucky, and Tennessee have a few good main roads. The others are very poor and rough.

A very important factor in rural fire protection is the nearness of buildings to the main highways and condition of lanes and barnyards. In Winneshiek County, Iowa, and in Talbot County, Md., though the former is rough and the latter is level, similar conditions exist. Buildings are located long distances from the roads, and lanes are not in good repair or are dangerous for apparatus to travel.

ALARM TRANSMISSION: Except in the very backward districts most farms have telephone service. In some of the New England towns fire alarm boxes are installed.

WATER SUPPLIES: Reservoirs and standpipes can be found on some farms. Generally water is none too plentiful, and when it is farmers will very seldom take advantage of it. This was quite true in Talbot County, Md.

Talbot County, Maryland.

There are six fire companies now operating in Talbot County, and the county has been divided into five divisions. This has reduced materially the number of runs which Easton makes into the county. Prior to the organization of the other five companies Easton answered alarms in the entire county, which necessitated ofttimes runs of thirty miles or more.

The organized companies have now formed a county association. The only arrangement which has developed from this association is the answering of alarms in districts. No specified type of apparatus has been used, and it varies from hand-drawn chemicals to motorized combination chemicals and pumpers.

The type of organization of the company has been practically the same—volunteer, the members paying dues. The fire companies are maintained through carnivals and other social activities.

One of the greatest difficulties the firemen have is to get water to put out the fire, even though the county is cut up by small inlets and bays. Water is easily obtainable if only runways or wharves were built so that the engine company could drop a suction hose into these bays. Another discouraging fact is that farmers will not keep their lanes improved so that apparatus can pass over them should a fire occur on the premises. It is the consensus of opinion of the Easton fire company that the majority of local fires are caused by defective flues.

Adrian, Mich.

Through the efforts of Chief H. A. Whitney of the Adrian, Mich., fire department, five years ago $9000 was raised in the city and from subscriptions among farmers, subscriptions ordinarily ranging from $1 to $25. A truck was purchased and put into service equipped with six 35-gallon chemical tanks carrying 24 extra chemical charges, permitting three hose lines working continuously if necessary. Alarms are transmitted by telephone, and as the roads are very good this enables the department to answer calls in a very short time. In 1927 approximately $42,000 was saved in the country by this apparatus. The city of Adrian houses and mans the apparatus, and for this consideration is allowed to use it in the city.

Association articles were drawn up at the time of the purchase of the apparatus, but the farmers have not been coöperating as much as they should in maintaining it. The plan of public subscription among farmers and other interested citizens does not seem in this instance to have worked out very well.

It was suggested by the chief that at least two milk cans containing water should be kept filled at each farmhouse. This would enable the firemen to recharge the chemical tanks and facilitate a rapid and more certain procurement of water.

Carmel, Ind.

Carmel, Ind., is a small town lying on the boundary of two townships in Hamilton County. Through the efforts of Mr. Jesse Johnson, a Ford truck equipped with three 35-gallon chemical tanks was put into service on June 1, 1923, for protection in the town and surrounding territory. At first the idea of fire protection of this nature was scoffed at by the farmers. However, the first call to the country saved a $5000 home from burning, though the barn, which had caught fire, burned to the ground. Immediately the attitude that farm buildings could not be protected from fire was changed.

This small Ford truck operated until October 7, 1927, during which time it answered a total of 56 alarms, 30 of which were to farm fires. The total

Blackinton.

The Burning of a Small Farm Dwelling.

1. Soon after the start of the fire. 2. Wooden shingle roof involved. 3. At this point fire department arrived. 4. Fire department in action. 5. Good hose stream, but too late to save building. 6. Fire out, twenty minutes after start.

loss suffered during that period was slightly over $42,000, with practically a saving of $130,000 to the property owners.

Indiana passed a law permitting townships to purchase fire protection through taxation. Enough enthusiasm had been aroused from the success of the small Ford truck to bring about an agreement between the town of Carmel and the two townships, Delaware and Clay, to purchase a larger piece of apparatus. On October 7, 1927, a fast truck chassis equipped with six 35-gallon chemical tanks was installed, at an approximate cost of $5000. As had been done with the other piece, this apparatus was housed in a 24-hour service garage, the chief of the department being the manager of the garage.

Alarms are transmitted from the telephone exchange to the garage by a special ring, whereupon all employees on duty at the garage man the apparatus and make the run to the fire. This arrangement seems one of the best encountered. Not only are there competent drivers and others at almost all times of the day to answer alarms, but the apparatus is assured of being well maintained.

Rural Fire Department Questionnaire.

Through the kindness of Mr. Moy Cook we obtained a partial list of rural fire department installations in Michigan, Ohio, Indiana, Illinois, Iowa, Minnesota, and Wisconsin. Time did not permit visits to these departments and therefore questionnaires were sent to them. Out of 253 sent out 74 reports were received. One stated that farm calls were not answered. In many cases the questions, if answered, varied a great deal. The following is a tabulation of the replies:

1. Name of town.
2. Is your fire department paid, part paid or volunteer?
   Six were paid, 15 were part paid, and 52 volunteer.
3. What fire apparatus do you have? (Type and amount. If pumping equipment, state capacity.)
   Thirty-five had pumping equipment varying from 150 gallons capacity to 600 gallons capacity. Thirty-three had only chemicals, 14 had only pumpers, and 21 had combination pumper and chemicals.
4. How is the department organized? (Number of men, officers, social functions, etc.)
   Replies varied so much that no concise summary is possible.
5. How is the department financed?
   Five were financed by popular subscription, 54 by city or town, 2 by city and townships, 5 by townships. There were 6 miscellaneous answers.
6. Area covered and condition of roads?
   Thirty-three claimed good roads, 21 claimed fair roads, and 2 claimed poor roads. Seventeen did not answer. The areas covered varied from 2 to 100 square miles.
7. How are alarms transmitted and how are members of department notified of alarms?
   In most cases alarms were transmitted by telephone and siren.
8. Are water supplies available? If so, give extent and arrangement.
   In the cities and towns 13 had no water or poor supply, 30 had cisterns or wells, 19 had water systems. In the country 24 had no water supply, and 34 had fair water supply.

9. Give fire loss figures and number of fires for past few years, if available.
   Very few answered this question, and it was hardly advisable to tabulate it.
10. What is approximate value of property protected by the department?
   Valuation of property was too uncertain to be of any value.
11. What are the principal causes of fire in your community?
   Twenty-seven had defective flues and heating appliances, 13 had lightning, 27 had sparks on wood shingle roofs, 6 spontaneous ignition, and 11 had carelessness.
12. Are the farms in your community generally protected by lightning rods?
   Fifty answered yes, 5 answered fair, 18 answered no.
13. Are the farmers in your community prosperous?
   Fifty-five answered yes, 13 answered fair, 5 answered no.

7. Fire Prevention.

Eight out of forty-eight states, namely, California, Indiana, Illinois, Iowa, Ohio, Oregon, Wisconsin, and New York, have passed laws permitting rural communities to purchase apparatus through taxation. The districts, of course, vary according to the make-up of the various states.

Another interesting fact relative to fire prevention laws, especially for buildings, was that eight out of forty-eight states had building codes. There was a reason for finding out about building codes. It was apparent during the time spent in the field that schoolhouses, both small schoolhouses and consolidated ones, and community houses in farming and rural districts were none too well protected against fire.

The small farm schoolhouses generally had wooden shingle roofs and oft-times chimneys were in poor condition. The consolidated schools are not generally constructed of fire-resistive materials throughout, and are located a long distance from fire protection.

Inability to acquire insurance interests farmers in fire protection. This was quite evident in Williamson and Johnson Counties, Ill. The burning rate has been tremendous in this section and very few companies will write farm insurance there. A different type of agricultural work is now being developed in this section; this is the growing of fruit. Large orchards have been and are being developed. The owners of these orchards naturally have storage houses and are unable to get insurance on these properties. They were rather eager to learn about rural fire protection and were quite open to suggestions.

Suggestions to the Committee.

1. That further and sufficient time be devoted to this study.

2. That a model law for the establishment of rural fire protection in states be drawn, that an effort be made to have the law accepted by legislatures, and that interest be aroused among farmers and in rural communities to lead them to avail themselves of this protection.

3. That a form on which to report fires and a form for the compilation of statistics be drawn up in such a way that an enlightened study could be made.

It would be necessary to induce as many states as possible to accept this form of report both for the individual fire and for the annual report. Much of the statistical data available was either very unreliable or so arranged that it was useless for a thorough study. The ideal plan would be to make a survey of each of the major farming states by counties. There are certain sections, of course, in which it would be useless to attempt such a program. However, there are quite a few states which need and would welcome the advice of the National Fire Protection Association on the establishment of fire protection in their smaller communities. It seems quite feasible that fire prevention committees could be organized in counties and in some cases in townships through farm bureaus, insurance companies, and coöperative farming organizations so that a study of the local fire problems could be made. This would not only tend to reduce farm losses, but also those in the smaller towns.

Fire Prevention Booth at Missouri State Fair.

Missouri Fire Prevention Association Booth at Missouri State Fair, Sedalia, Mo., August 17-24, 1929.

Fire-Resistance Requirements in Building Codes.

By S. H. Ingberg (Member N.F.P.A.),
U. S. Bureau of Standards.

A building code depends for its authority on the police power exercised by the community in behalf of safety to life and conservation of property rights against acts prejudicial to the secure enjoyment of ownership or occupancy privileges. The degree of protection the individual can assume as due from the community varies with the state of civilization achieved and the basic characteristics of the civilization concerned. Even in our country, settled from regions that had attained the highest state of civilization for the time, there was a recognizable difference in the amount of protection and control assumed by the community during the pioneer stages as compared with later periods. At the present time, however, all but a very small percentage of the urban population live under conditions substantially uniform from this standpoint, and while regulations such as building codes may have to be different for some localities as compared with others, because of difference in climatic and other conditions affecting building design, the degree of safety it is aimed to attain should be the same.

Fire as a Community Hazard.

Among the public safeguards that have been found necessary where buildings are built in proximity to each other are those pertaining to fire. Such regulations are founded on the long community experience that has been had with fires. Most of the older cities and ruins of cities that we find today are built on the ruins of still older cities, and in their destruction fire played an important if not a sole part. Within comparatively recent times many cities of northern Europe have been leveled by fire, and the comparative good degree of fire safety they now possess was apparently achieved in considerable part as a result of such experience. The different sections of our country have passed through or are passing through a similar range in experience. The rude huts housing the first settlers at Jamestown, Virginia, were burnt to the ground within one year, and thereafter fire added its share to the trials of this much afflicted colony, the state house being burned down four times and the church twice. The former was not rebuilt after the last (1698) fire, which involved a considerable portion of the town, on account of removal of the capital to Williamsburg. The church has been rebuilt behind its tower ruin as a memorial only during the past twenty years. Other colonies, like Pennsylvania, attempted to plan with reference to fire safety, and this has apparently been reflected in their fire experience. As the pioneer line moved westward the

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urban centers formed were often planned with less care in this respect, and many cities went through disastrous fires before better regulations governing building construction and fire protection were provided.

While modern fire fighting equipment and methods have made cities less defenseless against spreading fires, the cost of fighting fires and providing defense against a possible severe attack must be included as an item in the fire loss total. If a high degree of fire defense meant reduction of the fire loss to a relatively small amount then this expenditure would be well justified. This, however, is not necessarily the case, and even if fire protection efforts in face of adverse conditions can keep the fire loss much below figures that would otherwise obtain, it represents at the best a condition of unstable equilibrium.

Fire Districts.

CONSTRUCTION RESTRICTIONS.—As an aid in preventing spreading fires, cities have generally prescribed bounds comprising the congested or high-value districts, within which only fire-resistive or masonry-walled buildings may be built. A few cities have an inner zone within which only fire-resistive construction is permitted. It is apparent that the limits of such zones, and particularly those of the latter type, must be fixed with care in order not to restrict unduly the development of the city.

OCCUPANCY RESTRICTIONS.—Fire zone restrictions based on occupancy have been little used and only recently has occupancy become subject to formal control by means of occupancy permits in some cities. It is possible that, with a suitable combination of construction and occupancy restrictions, the congested district of cities can be made safer from the fire standpoint with less drastic measures than possible where the regulations are based only on construction. The fire hazard of many occupancies can, however, be sufficiently controlled by restrictions on the structures in which they are housed so as to require no more attention than those less hazardous.

RELATIONS WITH ZONING.—General zoning regulations do not take into account the fire hazard, although the restrictions on occupancy, height and on spacing of buildings have a bearing thereon. Zoning regulations are, however, not concerned with construction requirements and generally good coördination between them and fire restrictions is yet to be achieved.

Bases for Construction Restrictions.

Restrictions based on construction comprised within the above discussion have their justification in the different degrees of hazard involved when buildings of the different construction types burn or are exposed to fire.

THE FRAME BUILDING.—The building having frame and walls of combustible materials is vulnerable to fire attack, and walls and roof do not help appreciably to restrain the flames and the spread of embers and brands, the hazard increasing with the building area and height. The use of interior incombustible finishes, fire-stopping and large solid members will retard the progress

of fire within, and stucco, masonry veneer or other outside protection will make the building more resistant against fire attacks from the outside. However, such outside finish will not afford much protection to neighboring buildings when a building thus finished burns.

MASONRY-WALLED WOOD JOISTED BUILDINGS.—The masonry walls generally give full protection against exterior fire exposure to a blank wall area. Wall openings will not wholly nullify this protection, since the vulnerable area is decreased and a barrier is provided behind which a fire attempting to enter at the openings can be fought. When combustible interior construction and contents of a masonry-walled building burn, it will retain the burning material better than the frame building and decrease the exposure from hot drafts and radiated heat. A complete burning-out involves, however, collapse of floor and roof construction and generally partial collapse of exterior walls. After this stage of the fire is reached the building will burn as a unit with large unrestrained volume of flame and hot gases and opportunity for flying brands. Areas built upon exclusively with this type of building cannot, therefore, be considered free from conflagration hazard, particularly if occupancies housing large amounts of combustible materials are involved. The Baltimore conflagration of 1904 gave evidence on this point. However, the masonry walls, particularly if aided by suitable roof coverings, will help to prevent development of a spreading fire and enable one that has developed to be checked with less effort. The fire hazard of buildings with unprotected or insufficiently protected incombustible framing will come within the range of the hazard for the type discussed above.

THE FIRE-RESISTIVE TYPE.—This comprises buildings that can withstand a complete burning-out of combustible contents and trim without collapse of major structural members. Fires in such buildings are less hazardous to adjacent and neighboring construction than those in the types previously discussed, since the fire volume is broken up by the floor, roof, and wall constructions, and exit of flames and hot gases can take place only through the wall openings. There is little or no opportunity for the production of flying brands, and the hazard from radiated heat and hot air currents is much reduced. That spreading fires cannot arise in districts built upon with fire-resistive construction of moderate heights and not housing extra hazardous occupancies can probably be accepted without argument, assuming a minimum of fire fighting equivalent to that given by the volunteer forces in our smaller towns and cities. Conditions are somewhat different in the congested centers of our large cities, where buildings are high in proportion to the street width and occupy most of the available building area. Some observations relative to these conditions were given in a paper* before the 1926 meeting of the Build-

*"The Structural Factor in Fire Prevention," Proc. 12th Annual Meeting, Building Officials' Conference, pp. 126-132. QUARTERLY of the National Fire Protection Association, Volume 20, No. 2, pp. 170-180, October, 1926.

ing Officials Conference, the conclusions from which, quoted herewith, I have found no occasion to change:

"Present information supports the following conclusions relative to the fire-resistive type: (1) where a conflagration that has gained considerable headway in a district built up with non-fire resistive buildings reaches a district built up exclusively with fire-resistive buildings, it is to be expected that the buildings of the latter type immediately exposed and without protected wall openings will be damaged and, in part or whole, burnt out; and that with moderate protection and fire-fighting the other buildings of the fire-resistive group will not be ignited.

"(2) That in a district entirely built up with fire-resistive construction and with ordinary office, residential and commercial occupancies, excluding such occupancies as the regulations generally prohibit in congested districts, a fire cannot spread beyond the control of moderate fire-fighting effort.

"(3) That with office, residential, institutional, and the lighter mercantile and manufacturing occupancies from the fire-hazard standpoint, fires can be and generally have been confined to portions of the story where they originate by the help of moderate fire-fighting effort, even where the maximum of combustible trim usually permitted in fire-resistive buildings is present."

Requirements for Fire-resistive Buildings.

Buildings of this type are permitted to greater heights and with less restriction as to location and occupancy than buildings of non-fire resistive construction. In return, they are supposed to supply certain elements of safety under fire conditions, some of which have been indicated above. In order that they may function as such, it is apparent that no general or local collapse of building or important building members must occur in a fire consuming combustible contents and trim, otherwise the hazard to surrounding buildings, occupants and fire fighting would not differ greatly from that for the non-fire resistive type. They should be constructed so that the spread of fire within is restricted by means of fire division walls and enclosure of vertical and horizontal openings. The room partitions, while not necessarily having fire resistance sufficient to completely confine the fire, should exert some retarding effect on the spread and contribute little or no fuel for the flames.

Bases for Structural Protection Requirements.—While the fire experience with fire-resistive buildings has been generally favorable as far as most of the above requirements are concerned, there have been instances of collapse or other forms of failure that could have been prevented with proper design and construction details. Again, as it concerns a number of occupancies, requirements have been in force that have resulted in uneconomical construction and prevented the use of the fire-resistive type under circumstances where it could have found application if the protection requirements had been made with reference to the actual or potential fire hazard presented

by the given situation. That the protection applied should be in proportion to the severity of the fire to be expected from the occupancy to be housed can be accepted without argument. The information needed in applying this principle includes (1) weight and character of combustible contents and building trim for the building concerned; (2) the probable severity of a fire completely consuming such combustibles, interpreted as equivalent to a given period of the fire exposure used in furnace tests of building construction and materials; (3) fire-resistance classifications of building constructions and materials based on performance in furnace tests to make possible the selection of protections proportionate to the fire severity to be expected. These items will be briefly discussed.

(1) Combustible contents and trim.—No considerable difficulty is involved in estimating combustible contents for a given building or even for a given occupancy. Typical pieces of furniture or units of contents can be weighed and the weight of finish, floors and trim computed. The total weight for a given or typical floor bay divided by the pertaining floor area gives then the measure of the distributed combustible contents.

A somewhat better measure of the fire hazard is the calorific or fuel value of the contents expressed; for example, as British thermal units per square foot of floor area. A considerable range of materials have calorific value of within the range 6500 to 9000 B.t.u. per pound, including wood, paper, sugar, starch, cereals, straw, cotton and wool. Animal, vegetable and mineral oils, fats and waxes have generally calorific values within the range 16,000 to 20,000 B.t.u. per pound. The fuel value of charcoal and coal ranges from 10,000 to 15,000 B.t.u. per pound, but considering the slow rate of combustion of most types of coal the fire hazard from them can apparently be discounted.

(2) Severity of building fires.—Having determined the amount and kind of combustible contents, and assuming a fire-resistive enclosure in the form of a building or portion thereof that will maintain itself during a complete burning-out of contents, it is necessary to know the probable severity of the fire. The difficulty of obtaining this information from observation of building fires and fire ruins led me to consider the possibility of obtaining it by means of burning-out tests in buildings constructed for the purpose and outfitted to represent typical occupancies. This work has been completed as far as it concerns office and record storage occupancies where the contents consisted of wood and paper. By conducting the tests in rooms of different sizes and floor finishes, and by introducing variations in the method of starting the fire, a fair check was obtained on the reliability of the method. The details of the tests and their results will not be given here* except for the following table, which gives equivalent fire durations for given weights of wood furniture and paper having the calorific values indicated.

*See footnote next page.

Equivalent Fire Duration for Office and Record Room Occupancies in Fire-resistive Buildings Equipped with Combustible Furniture and Shelving.

	Total Combustible Content (Inclusive of finish floors and trim)	
Lbs. per sq. ft.	Assumed B.t.u. per sq. ft.	Equivalent Fire Duration Hrs.—min.
10	80,000	1 — 00
15	120,000	1 — 30
20	160,000	2 — 00
30	240,000	3 — 00
40	320,000	4 — 30
50	380,000	6 — 00
60	432,000	7 — 30

The periods given include an element of exposure of the degree attainable by the methods of starting the fire employed in the tests. It might be added that we will conduct in the near future burning-out tests with petroleum products having calorific values about twice those for wood and paper, and also tests with greater amounts of combustible materials than 55 pounds per square foot, which was the limit in the tests so far completed. By means of such tests it is hoped to extend the limits of application of the results obtained with the occupancies included in the tests.

(3) Fire resistance classifications of building materials and constructions. —Classifications based on performance in fire tests conducted according to present recognized standards are available for a representative range of columns and column protections, solid and hollow walls of brick, hollow tile and concrete blocks, and for partitions of gypsum blocks, and of plaster applied on metal lath, wood lath and plaster board. The large number of fire tests of floors conducted under the auspices of the New York City Bureau of Buildings during the period 1896 to 1920 give important information on fire resistance of floors, particularly as it concerns ability to support load and confine flames and smoke. The latter fire-testing procedure, however, prescribes certain temperature limits for the upper surface of the floor which must not be exceeded as a safeguard against ignition of materials in contact with it, a matter that was not included in the earlier specifications for fire tests. However, for constructions through which there is little flow of heat by convection, the temperature transmission through floor slabs will not be greatly different from that pertaining to walls and partitions, hence the results with the latter can be applied with a fair degree of approximation. Also, the fire exposure condition for projecting beam and girder flanges is not far different

*The results of the tests were given in a paper, "The Severity of Building Fires," published in the Proceedings, 14th (1928) Annual Meeting of the Building Officials' Conference of America, pp. 87-97; QUARTERLY of the National Fire Protection Association, Vol. 22, No. 1, pp. 43-61, July, 1928; Safety Engineering, August-September 1928; the Architectural Forum, Vol. L, No. 5, pp. 775-782, May, 1929. Also a briefer account on "Gauging the Severity of Building Fires" given before the National Fire Waste Council, Chamber of Commerce of the United States, September, 1928.

from that for columns, the results from which can be used if applied with caution. It might be noted that in applying the test results for columns and walls to floor constructions, the stability of the protections subject to cracking and spalling should be assured by means of mechanical ties, since for horizontal floor members such effects are likely to be relatively more severe.

As a further aid in interpolation and extension of test results, recourse can be had to the "law of times," which has been found to hold very well for solid walls and within limits for hollow walls. Interpreted for the conditions in the fire test, this states that for a given constant fire exposure on one side of a slab the time required to reach a given temperature rise on the unexposed side is proportional to the square of the slab thickness, assuming no heat loss on the unexposed side. Even with the heat loss that occurs, the dehydration effects from free and combined water, and the varying temperature of the fire results from tests, and those computed with the aid of this law agree with surprising consistency.

(4) Factors of safety.—The results of the fire tests are reported as ultimate fire resistance periods, or the time of failure according to some limit prescribed in the test specification, the average value being used where results of more than one test of identical or nearly identical constructions are concerned. In applying these results to fire conditions in buildings, it is necessary to introduce a factor of safety to allow for variations in materials, workmanship and fire conditions. Thus, in tests of supposedly identical constructions, a considerable range in results obtains, and the factor of safety must be taken so that the lower range of results will represent fire resistance a little higher than the hazard against which the given protection is applied. While there is room for discussion as to what this factor should be, the variations we have obtained in our fire tests and the degree of reliability with which the fire severity of a given condition can be estimated indicate that for building constructions generally this factor should not be less than $1\frac{1}{2}$. On this basis a fire condition in a building estimated as equivalent to the first two hours of the furnace test calls for protections that have ultimate fire resistance of three hours. Some care is needed in the phrasing of building code provisions in order that the distinction between ultimate fire resistance periods of constructions and the fire hazard of occupancies may be clear, and that the former be applied with a proper factor of safety. The writer has been unable to justify any difference in requirements for the fire severity to be assumed as between the different classes of building constructions (columns, walls, floors, etc.) concerned. It is necessary to assume that the fire test duplicates the fire condition in the building, also collapse of a floor bay may carry with it the adjacent columns.

Maximum and Minimum Limits.—Whatever be the combustible contents of the occupancy, it may be necessary to prescribe a minimum fire

resistance to provide for conditions that cannot be supervised or controlled by municipal authorities. Just where the line should be drawn can perhaps best be determined by surveys of existing buildings, but the justification for such a minimum limit must be conceded.

A maximum limit beyond which building code requirements should not go might be premised on fire extinguishment after a certain period for buildings below a given height or area. While here again there is ample ground for discussion, it has been the writer's position that buildings above given height limits should be designed so as to be capable of withstanding a complete burning out of combustible contents and trim without collapse of major structural members. Fire extinguishment, which we fortunately can assume will come in at some stage for most fires, can find ample scope in limiting the damage to contents and building finish and trim, and the structural elements of the building should be required to give a safe background for fire fighting efforts.

Concentrations of Combustibles.—Closely allied with the above is the method of allowing for concentrations, such as record rooms and law libraries in office buildings. Where these occupy only one floor bay or less and are not separated from the rest of the area by means of fire-resistive partitions, there would be considerable dissipation of heat to the surrounding space. Otherwise the general building will have to take these concentrations into account if they are permitted anywhere within the building. If segregated to certain portions thereof, the necessary additional protection can be applied at relatively low expense. The hazard can be reduced by the use of incombustible shelving or containers. If fully enclosed in metal files, enclosed metal shelves or similar means, the hazard is reduced to a point where it would require no greater protection than the rest of the building.

Comparison with Other Structural Requirements.—While the method outlined above for gauging the fire hazard and providing the proper protection may seem to involve much detail, it is really much simpler than the methods that must be applied to assure structural safety from other standpoints. The data needed for applying the method, while admittedly incomplete, supply, at the least, as good a background as was available on live and wind loads and strength of materials to the pioneers in modern structural design. More important than accuracy of detail is the general method employed, and if this is correctly founded such changes as come from more complete information are neither revolutionary nor burdensome.

Exterior Protection.

Such protection should be required only as it concerns the fire conditions to be guarded against, and where no present or potential future hazard exists no protection should be required, irrespective of building type. An excellent exposition of the principles involved is given in the reports (1924-25) of the

Committee on Protection of Openings in Walls and Partitions of the National Fire Protection Association. While the committee's conclusions as to the specific amounts of protection required for given situations need not necessarily be accepted, the principles used in gauging the exposure appear well founded.

Roofing.

Roofs are a species of exterior protection or hazard, and regulations pertaining to them are best based on the protection needed from, or the hazard to, the adjacent and neighboring buildings. While such conditions, for the purpose of regulation, may be assumed uniform within given fire zones, the roofing requirements should preferably not be made uniform for given general construction types. The type of building construction will need attention only as it concerns the base on which the roofing is applied, combustible framing and sheathing requiring more protection than incombustible base constructions.

Egress Requirements.

In the preceding discussion no attempt has been made to differentiate between the effects of the different types of requirements in achieving greater safety to life as against the protection to property. Very few structural requirements can be said to effect the one without in some measure aiding the other. Thus fire stops and fire-resistive interior constructions and finishes, in retarding the spread of fire and smoke, afford under many conditions a measurable protection for the occupants. Some structural details, such as fire-resistive construction or finishes between units in double or duplex dwellings, while possibly not justified on the score of protection of property, might be required as protection for occupants.

Some types of requirements, such as those pertaining to roofing and to protection of exterior openings, can be seen to relate mainly to property protection. Those having to do with building heights and areas, interior protections and enclosure of vertical and horizontal openings have a vital bearing on both. Strictly egress requirements pertain to number, size and location of exits and protection of exit ways. The principles on which these requirements are to be based have received much discussion, and a fair unanimity obtains as to the occupancy, construction, and protection factors that should be recognized. As regards the relative weight that should be given them, more difference of opinion exists, and it is hoped that further careful consideration and checking of proposed standards with the facilities provided for typical occupancies and constructions, and the experience had under actual or assumed fire conditions will prove fruitful.

The structural factor is probably the most difficult one to evaluate from the standpoint of safety to life under fire conditions. For buildings occupied only during working hours, and also for places of public assembly, the type of construction for buildings below a given height or size is of less importance than the provision of adequate means of exit and protection for such exits.

As exit should be effected in a comparatively short time, smoke-tightness is of as much importance as fire resistance. Hospitals, asylums, and corrective and penal institutions need to be of superior construction with a minimum amount of combustible trim, on account of the longer time of exit that must be allowed and the greater hazard from the occupancy. With increase in building height, restrictions on construction type, finish and trim have been made on account of difficulty in providing adequate exit facilities.

The largest loss of life occurs in buildings of institutional and residential occupancy, where, particularly, fires occurring at night can gain much headway before being discovered. Here the type of construction or construction details appears to enter to a greater extent than for commercial occupancies. Provisions for fire-stopping, protection of heating equipment and chimney, and incombustible floor and ceiling finishes represent apparently the limit that can be required for buildings of moderate height. Beyond certain height limits, which apparently should be placed lower for residential than for office or light commercial occupancies, fire-resistive construction with enclosure of vertical and horizontal openings would be required.

ALL OUT!
By Dahl
ALLEN DESIGNATES "FIRE PREVENTION WEEK"
SEE?
JEWELRY STORES WILL COOPERATE BY FEATURING CIGAR LIGHTERS THAT DON'T LIGHT!
SWAP!
THIS IS FIRE PREVENTION WEEK
COAL COMPANIES WILL SUPPLY US WITH THAT "SAFE-SLATE"
NON INFLAMMABLE
"ANT-COAL"
THIS IS F.P.W.
BEWARE THE STRANGER WHO ASKS FOR A "LIGHT"—HE MAY BE A STOOL PIGEON!
YOU JUST DON'T WANT TO GO DOWN CELLAR AND LUG UP THE WOOD!
NOW IS THAT THE SPIRIT?
WHY "FIRE-PREVENTION WEEK"?
WELL—THE BEARINGS NEED TIGHTENING—THE VALVES NEED GRINDING AND THE CHIEF WANTS TO LOCATE THAT SQUEAK—IT WILL TAKE ABOUT A WEEK.
YOU CAN'T DO IT BOSS! —THIS IS "FIRE-PREVENTION WEEK"!
DAHL

—*Boston Herald.*

The Swan-Finch Oil Fire.

By Schedule Rating Office of New Jersey,
(Member N.F.P.A.).

An oil barge, the *James Horan,* caught fire while moored to the Warner-Quinlan docks at Linden, N. J., on the morning of September 14th, 1929. The flaming barge was cut loose, and in the course of about nine hours drifted northerly in Staten Island Sound or Arthur Kill, finally setting fire to the Swan-Finch Oil Company's plant near Morse's Creek.

Preliminary Events.

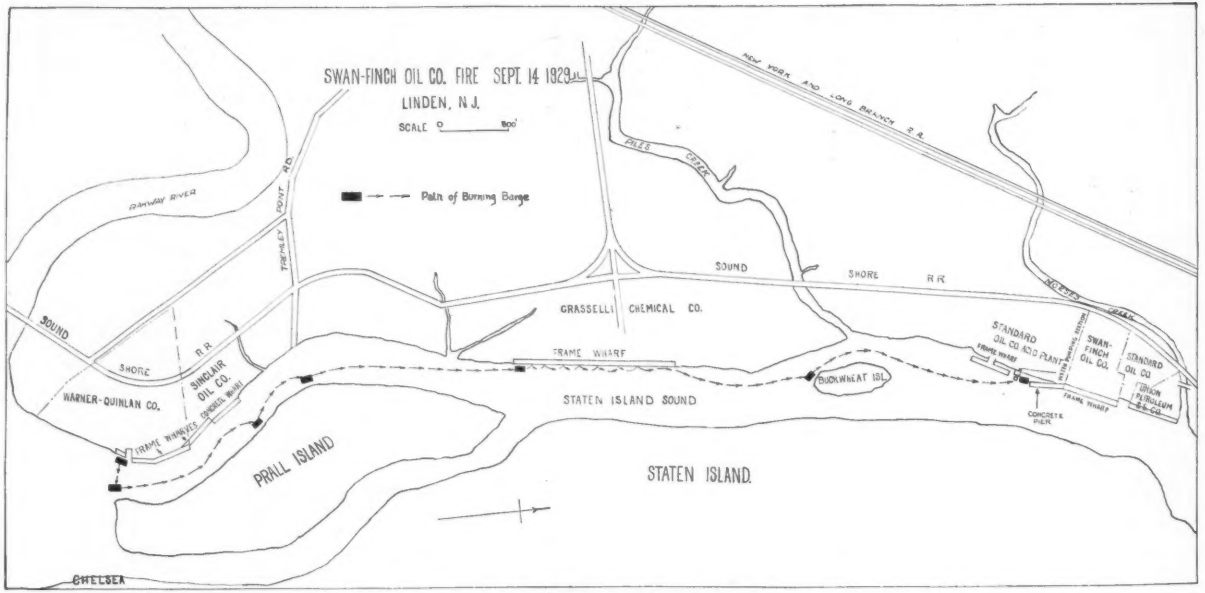
The sea-going oil tanker *Cecil County* wished to discharge a cargo of crude oil at the Warner-Quinlan refinery at Linden, N. J. Fully laden, the *Cecil County* required a greater depth than was available at the Warner-Quinlan docks. To permit the *Cecil County* to dock, a portion of her oil cargo was transferred to the oil barge, *James Horan,* while anchored off Chelsea, Staten Island. The oil barge *James Horan,* owned by the Lambert Transportation Co., was built entirely of wood. Apparently there were no tanks, and planking, spiked directly to the inside of the ribs of the barge, formed the oil reservoir. There were no indications of partitions dividing the interior of barge. The barge was decked over. On the morning of September 14th, the *Cecil County* and the oil barge were moored to the Warner-Quinlan docks; the barge was at the ship's bow. The barge contained about 6000 barrels of oil.

Cause of the Fire.

At about daybreak on September 14th, a severe electrical storm was passing over Staten Island Sound. The captain on the *Cecil County,* in his berth at the time, heard lightning strike, and upon rushing to a window saw a third of the barge in flames. There was one man on the barge at the time; he escaped. It is not known whether fire started by a direct hit on the barge, or whether oil fumes were ignited by lightning striking near by on the wharf. Employees at the Warner-Quinlan plant who saw the flash said lightning seemed to strike the boat; there are no marks on the wharf to indicate that the lightning struck there.

Progress of the Fire.

Immediately after the fire started, the crew of the barge with the help of Warner-Quinlan employees cut the barge loose from the wharf and a westerly wind blew the flaming barge toward Prall Island. In the meantime a plant employee pulled an A. D. T. box at the Warner-Quinlan plant. This box is recorded at the Newark A. D. T. office as coming in at 6:36 A.M. The Newark office records the call as being transmitted to the Linden Fire Department by



PATH OF THE BURNING BARGE.

Ignited by lightning at the Warner-Quinlan Wharf, the burning barge was cut loose and drifted with the wind and tide, finally breaking up at the concrete pier of the Standard Oil Co. after drifting over two miles in about nine hours. The burning oil set the Swan-Finch Oil Co. plant afire. (See diagram on page 169.)

telephone at 6:36 A.M.; it was stated that a telephone connection was obtained immediately. The Linden Fire Department records the alarm as being received at 6:33 A.M. Upon responding with one ladder and two engine companies, Chief Miller found the flaming oil barge floating a considerable distance out in the Sound and no fire at the Warner-Quinlan plant. Damage at the plant due to exposure was negligible. A passing tugboat nosed up to the barge and pushed it on mud flats at south end of Prall Island. At about 7:00 A.M. Chief Miller of Linden telephoned the Marine Division of the New York Fire Department and advised them of conditions.

The wood hulled fire boat *Zophar Mills* of the New York Fire Department responded at about 8:00 A.M. The *Zophar Mills* stopped at the Warner-Quinlan dock and took aboard Chief Miller and some firemen, three portable foam generators and 200 forty-pound cans of "foam" powder. The fire boat approached the flaming barge and with three 2-inch nozzles with 150 ft. of hose each and foam units used up the 8000 lbs. of foam powder. The crew managed to direct foam into the barge, but were not successful in extinguishing the fire. The captain of the *Zophar Mills* then landed and sent in a call to New York for an additional fire boat. The steel fire boat, *Wm. J. Gaynor,* responded at about 9:30 A.M. The *Wm. J. Gaynor* approached the barge and discharged a heavy stream of water into it. In about two minutes the oil in the barge boiled over and burning oil spread on the Sound. The blazing oil burned out before reaching either shore. Acting Chief Riddle of the New York Fire Department, Marine Division, arrived about 10:00 A.M. After a conference it was decided to let the barge burn out. Chief Miller and the Linden firemen were landed and about 1:00 P.M. returned to the fire station with apparatus. The fireboat *Zophar Mills* moved to Chelsea as a protective measure. The fireboat *Wm. J. Gaynor* remained near the burning oil barge.

About 2:30 P.M. the incoming tide freed the barge from the Prall Island mud flats and caused it to drift northerly in Staten Island Sound. The *Wm. J. Gaynor* made an attempt to ground the barge on mud flats of Prall Island opposite the Sinclair Oil plant, but was unsuccessful. The required draught of the fireboat was so much greater than that of the barge that the fireboat could not follow the barge into sufficiently shallow water to ground it. The flaming barge continued its northerly progress; it grounded for a moment on the point of Prall Island about opposite Tremley Point Road, but the tide soon lifted it free. The tide was moving the barge at a four-mile an hour rate.

After leaving point on Prall Island opposite Tremley Point Road the barge veered to the westerly bank of the Sound and the Grasselli Chemical Company's wharves. Seeing the flaming barge approaching, employees at the Grasselli plant cast loose a pile driver and several chemical barges. The chemical barges drifted to the North and out of the way, but the flaming oil barge collided with, and hooked fast to, the pile driver.

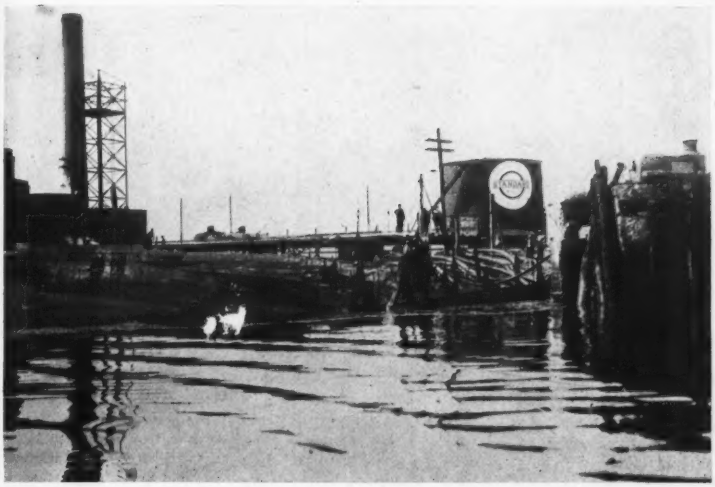
At 3:18 P.M. the Linden Fire Department received a box alarm from the Grasselli plant. Chief Miller of Linden arrived with one ladder and two engine companies as the flaming oil barge collided with the pile driver, and found plant fire protection equipment in readiness. After colliding, the oil barge and the pile driver bumped along the Grasselli docks, starting many small fires. Since the attempt at grounding the oil barge, the fireboat *Wm. J. Gaynor* had been following the barge. As the oil barge bumped along the Grasselli wharves the fireboat played one hose stream on the side of the barge to cool it, and three hose streams on Grasselli plant to quench the small fires that started. The fire department and the plant employees also followed the oil barge and pile driver along wharves extinguishing the small fires as they started. When the oil barge neared the north end of the Grasselli wharves the fireboat managed to nose the oil barge out into Sound and the pile driver, burning briskly by now, broke free and drifted on ahead of the oil barge.

When the fireboat pushed the barge away from the Grasselli wharves, Chief Miller of Linden telephoned the Standard Oil Acid Plant near Morse's Creek to advise them to prepare for trouble. It developed that the Standard Oil Co. had had lookouts posted on their docks since morning to keep track of the barge and had arranged for company tugs to be held in readiness. The Linden chief ordered his apparatus and men to move to the Acid Plant. One Linden pumping engine stuck in the mud at the Grasselli plant and was left; a hose company from Linden headquarters was sent to the Acid Plant. A call for help was sent to Elizabeth and one engine company responded immediately; a short while later two additional Elizabeth engine companies responded.

By the time the flaming oil barge was freed from the Grasselli wharves, a slight southerly wind had laid an impenetrable smoke screen over the Sound north of the barge. The fireboat made an attempt to ground the barge on the south end of Buckwheat Island opposite Piles Creek, but due to lack of visibility missed the island. The barge, after a momentary hesitation, continued to drift northerly in channel. It is said that the windows in the pilot house of the fireboat were melted out during this maneuver.

The burning pile driver in the meantime had drifted northerly ahead of the oil barge and grounded in a small cove a short distance south of the Standard Oil Acid Plant wharves. The Linden firemen with several streams from the Acid Plant water system quickly extinguished the pile driver fire.

The water front from the Standard Oil Plant northward starts with a frame wharf several hundred feet long parallel to shore. At the north end of this wharf is a frame building on piles, apparently equipped with condensing apparatus. About 40 ft. directly to the rear of this condenser house at the shore line is the new fire-resistive water pumping station of the Standard Oil Co. To the north of the condenser house is about 100 ft. of open water. A reinforced concrete pier about 700 ft. long extends, from a point about 100 ft.

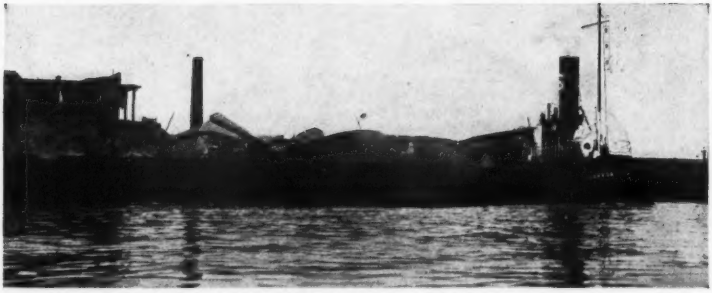


International.

Wreckage of the barge, where it collapsed against the end of the concrete pier of the Standard Oil Co.

north of condenser house and about 50 ft. out from shore, northerly to meet the shore at north boundary of the Acid Plant. Adjoining Acid Plant on the north is the Swan-Finch Oil Co. Plant. The Swan-Finch Oil Co. manufactures various kinds of oils and greases. The waterfront at the Swan-Finch plant consists of a wood wharf for full plant frontage. North of the Swan-Finch dock is a small space of open water and then continuous frame wharves, used by the Standard Oil Domestic Division and the Union Petroleum Steamship Co., to mouth of Morse's Creek.

When the blazing oil barge approached the Standard Oil Acid Plant, companies from the Linden and the Elizabeth fire departments and plant employees had hose lines laid and all equipment ready to protect the plant and one tug of the Standard Oil Co. was towing other barges out of danger. The oil barge bumped the condenser house at the north end of the Acid Plant dock and swung around into open water between the condenser house and the concrete pier. Then the blazing oil barge hit the south end of the concrete pier and the whole end of the barge caved in; practically all the blazing oil was dumped on to the water. Carried by the tide at about a four-mile an hour rate, the blazing oil swept around outside of the concrete pier and under the wharf at the Swan-Finch plant. After the barge hit the pier attempts were made to lay hose streams to drive blazing oil away from the wharf, but the oil spread too fast. Employees of the Acid Plant continued to play water and foam streams into the remains of the burning barge which had grounded while the



International.

Wharf of the Swan-Finch Oil Co. Burning oil under the wharf started the fire that quickly spread to the buildings in the rear.

fire departments moved to the Swan-Finch plant. The blazing oil spread north almost to the north end of the Swan-Finch wharf before burning out.

From the time the burning oil in the barge boiled over, due to the fire stream from the fireboat *Wm. J. Gaynor,* to the time the barge broke up at the Standard Oil concrete pier, except for a space at the Grasselli docks, the efforts to control the situation depended upon the fireboats and consisted mainly of keeping the blazing barge in a position where it would cause no damage until it burned itself out.

Swan-Finch Plant.

The Swan-Finch Oil Co. compounds lubricating oils and greases and refines fish oils. The plant consists of about twenty buildings and numerous moderate and small size outside oil storage tanks. There are six large buildings; one is of joisted brick, one of semi-fireresistive, one of sheet metal on steel frame and the remainder of metal-clad frame construction; only the brick and the fire-resistive buildings are over one story high. The remaining smaller buildings are all one-story and mainly of metal-clad frame construction. At the water front is a frame bulkhead and, over the water, a dock of 2-inch plank on piles. About midway along dock is Building "A," a metal-clad frame building, built partly over the wharf and partly behind the bulkhead, about 22,000 sq. ft. ground area and used for shipping and storage. About 25 ft. in the rear is Building "B," a 2 and 3-story semi-fireresistive building of about 14,500 sq. ft. ground area and used for compounding, filling and storage. Attached to rear of, and communicating with Building "B" is Building "C," a 1-story metal-clad frame structure of about 6000 sq. ft. ground area and used for cleansing and filling fish oil. North of "B" is Building "S," a 1-story, all metal building of about 12,800 sq. ft. ground area and used for storage of oil in barrels and cans. South of "B" is Building "E," a 1-story metal-clad frame building, of about 13,600 sq. ft. ground area and used as cooperage shop. These and several smaller metal-clad frame buildings were in fire area.

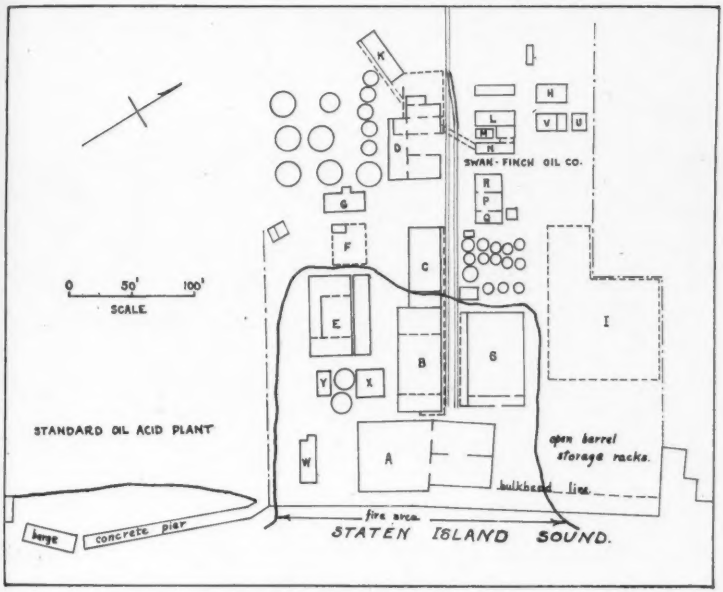


Diagram of Swan-Finch Oil Co.

BUILDINGS.

A—shipping and storage.
B—compounding.
C—filling house.
D—fish oil pressing.
E—cooperage shop.
F—barrel shed.
G—oil pump house.
H—carpenter shop.
I—barreled stock storage.
L, M, N } soda grease dept.
R—machine shop.
P—boiler room.
Q—pump house.
U—garage.
V—wash house.
W—oil storage.
Y—shop drawing.

When the blazing oil from barge swept under the Swan-Finch wharf flames soon came through floor of Building "A," which was built partially on the wharf, and ignited the contents. Very quickly Building "A" was a mass of flames. Firemen and plant employees attempted to lay a water curtain between buildings "A" and "B," but before enough hose streams could be stretched, "B" was aflame. Exposed windows of Building "B" were of thin glass and in wooden sash and as soon as the windows broke heat ignited oil and grease in the building. By this time more hose streams were brought into play and an attempt was made to curtain Building "A" and "B." While there were many minor explosions, such as of oil drums, no heavy explosions were reported. The fire soon communicated from Building "A" to metal-clad frame additions on Building "S" and then to interior of Building "S." Now a water curtain was laid to protect buildings "E," "C," "I," and the frame pump house at rear of Building "S." Some very effective work with two hose streams inside of frame Building "C" stopped progress of the fire in that direction at a frame partition 25 ft. back from Building "B." Building "E"

Building "B," east end and north side of 3-story fire-resistive section, showing collapse of reinforced concrete roof.

burned to the ground. To the north of Building "B" the metal-clad frame water pump house was successfully protected, as were a group of oil storage tanks and an open shed "I." There were 26 hose streams on land from private hydrants and from pumping engine drafting from Morse's Creek. From the Sound the fireboat *Wm. J. Gaynor,* and several tugs were directing heavy streams on the fire. The water supply at hydrants was said to be plentiful at all times.

Losses.

The total fire loss is roughly estimated to be $900,000. The Warner-Quinlan plant suffered only the scorching of its wharves. The Grasselli Chemical damage consisted of many scorched places from the numerous quickly extinguished fires. The pile driver, which was moored to Grasselli docks, was a total loss. The oil barge, of course, was a total loss. The Standard Oil Acid Plant pumping station and condenser house both suffered; in the pumping station, the wired glass windows were melted out of their metal sash and the exposed brick wall was spalled to some extent; the frame condenser house had one corner burned.

The Swan-Finch plant suffered the major portion of total loss. They had a total loss on the three small metal-clad frame, two large metal-clad frame, one large all metal, and one semi-fireresistive building. One metal-clad frame building was damaged. Considerable barreled oil and grease on dock was consumed by fire. Valuable machinery was lost with the destruction of the semi-fireresistive building; the loss of this building stops the grease and lubricating oil production.

The loss of fire fighting equipment consisted of scorched paint on fireboats, and, it is said, the loss of pilot house windows on the fireboat *Wm. J. Gaynor* and several lengths of 2½-inch hose which were burned. Two men were slightly injured.

Construction of the Semi-Fireresistive Building.

Of the buildings within the fire area at the Swan-Finch Plant only the semi-fireresistive Building "B" could be expected to offer any resistance to the spread of fire. Had Building "B" withstood the exposure from Building "A," it is possible that fire could have been confined to the wharf front and ends of other adjacent buildings.

Building "B" was constructed in two parts and with three fire areas. The old section was 2-story with 12 and 16-inch brick walls; beams, girders and columns of steel protected with two inches of concrete; 6-inch reinforced concrete floors and roof. The windows in this building were unprotected and of plain glass set in wooden sash; on the southerly side of building iron eye blocks for mounting fire shutters could be seen, but there were no shutters. The old section was divided into two fire areas by 12 and 16-inch brick wall with two openings on the first floor, one equipped with a 1-inch and the other with a 2-inch, tin-clad, non-standard, non-automatic fire door and with two openings on the second floor, each equipped with a standard, self-closing, 2-inch metal-clad fire door.

Of the fire area nearest Building "A," the first floor, used for filling and compounding oil, was equipped with five tanks from 18 to 35 bbl. capacity, and the second floor for general offices and laboratory. No vertical opening in this area; outside iron stairway. The first floor of the other fire area in old section of building, used for compounding and filling, was equipped with 10 tanks of 40 and 50-bbl. capacity, two steam coil heated mixing tanks and for soap heating in steam kettles. The second floor of this area, used for compounding and storage, has open troughs into which is dumped oil to drain to tanks below, a "warm" room with 4-inch tile walls, and, stored on floor, about 25 bags of flower of sulphur, 1 bbl. of resin, and hydrated lime in paper bags.

The occupancy of the first floor of the old section of Building "B" included tanks for compounding oil, varying from 18 to 50 barrels capacity. The second floor was occupied for oil compounding and storage, with open troughs into which oil was dumped to drain to tanks and the floor below. About 25 bags of sulphur and one barrel of resin were stored here. This area had one open stairway.

The more recent section of Building "B" was 3-story of skeleton construction. The curtain walls were of 4-inch terra-cotta tile; columns, beams and girders of steel protected with two inches of concrete. Floors and roof were of reinforced concrete, six inches thick except for third story, which is iron grating supported by unprotected steel tank supports. The windows were

Building "B," east end and south side. Fire entered through unprotected windows here.

of plain glass. The more recent section is divided from the old section by 12 and 16-inch brick wall with two openings each on first and second floor; openings protected by non-standard, non-automatic, 1-inch, tin-clad fire doors. One door communicates with metal-clad frame Building "C" and is protected by a non-standard, non-automatic, 1-inch, tin-clad fire door. The first floor was used for filling barrels and kegs with grease from bottoms of mixing tanks which extended through from the second floor. The second floor was occupied by an open steam coil heated tank for melting hog fat, and steam heated compounding tanks. On the third floor were paraffine oil tanks. One iron stairway with open treads led from the first to the second story; outside iron stairway from the second to third story. One open hoist extended between the first and second story.

Effect of Fire on Semi-Fireresistive Building.

The 12-inch walls of the fire area nearest Building "A" were demolished to the first floor level except for a short distance adjoining the division wall of the other fire area. The 16-inch first and 12-inch second story fire wall between fire areas was demolished to the second floor level. The 16-inch first and 12-inch second floor walls of the middle floor area were intact, except for cracks and chunks from the top, on the south side; but on the north side were demolished practically to first floor level. The protected steel columns and girders in this middle fire area were generally intact, although on the north side near the wall that failed they were somewhat twisted out of position. The

Another view of Building "B," showing the character of the damage.

6-inch reinforced concrete roof of the middle fire area was sagged and torn away from supports in the majority of panels. The greater damage to the north side of building may be partially accounted for by the exposure from Building "S" and the presence of a number of tanks containing sulphur-bearing oil on the second floor along the north wall. The 6-inch reinforced concrete second-story floor was intact except on the north side. Concrete protection on steel work was chipped on corners throughout.

The fire wall between the 2-story section and the 3-story section was demolished except at south end. The skeleton frame of the fire-resistive building came through the fire in fair condition except near the fire wall. Of the 28 columns in this section five failed completely to the second floor and one was twisted. Two of these columns which adjoined 2-story portion failed to first floor level. Four of the columns that failed surrounded an open freight elevator to second floor. The 4-inch tile curtain walls of this section fared poorly. Between each column were three 4-foot panels of tile; the middle panel containing a window opening. Generally the middle tile panel was demolished to the bottom of the window opening and the side panel to a point about one third the way down from girder above. The 6-inch reinforced concrete roof of the 3-story section generally failed, but the second-story floor was left intact. The unprotected steel tank supports failed and dropped tanks to second floor level.

Discussion of Fire Extinguishing Efforts.

It is thought that the foam, discharged on burning oil barge while it was grounded at south end of Prall Island, was ineffective chiefly because it was improperly applied. This does not imply criticism of those in charge of fire-boat, but means that foam probably struck the oil with too much force and too near the middle of the burning surface, due to angle from which it was necessary to apply the foam.

No attempt to secure burning barge from further motion while grounded on Prall Island was reported.

The spread of fire at the Swan-Finch plant, it is thought, was due chiefly to lack of protective devices such as fire shutters or wired glass windows at the wall opening in Building "B" and the congestion of buildings. It could not

be expected that the full number of hose streams would be immediately available at start of the fire in this part, as there was no certainty as to the point where the barge would land and the sudden collapse of the barge was not expected. Congestion of buildings made impossible the suitable placing of hose streams. Had exposed wall openings in Building "B" been protected it is highly possible that they might have resisted even the extreme heat that was encountered for the short time required for Building "A" to be completely consumed.

Union Pacific Dock Fire, Seattle.

Report by Washington Surveying and Rating Bureau,
(Member N.F.P.A.)

A serious fire of unknown origin damaged the underdock space and walls of the warehouse of the Union Pacific Dock at Seattle, Washington, during the afternoon of July 17, 1929. This fire is of particular interest in that it indicates the hazards incidental to the highly flammable coating of creosote and bilge oil on the piling and timbers beneath the wharf and emphasizes the need of extending bulkheads under the pier deck downward to low tide level in order to effectively retard the spread of fire. As in similar fires, the desirability of automatic sprinklers in the space under the pier deck was demonstrated. The fire is also of interest in that it was practically confined to this space, due largely to the action of the automatic sprinkler equipment in the pier shed, aided by heavy floor construction. (See Frontispiece.)

The Property Involved.

The pier itself was approximately 512 feet long, and about 162 feet wide. The walls were of corrugated iron on a skeleton wood frame. Continuous rows of plain glass windows were on the north and south sides. The roof was of tar and gravel with a monitor 60 feet wide, rising 7 feet above side roofs. Draft curtains, extending down to lower chords of roof trusses, were spaced approximately 95 feet apart, and each roof section was equipped with a metal slatted ventilator. Sides of monitor had continuous rows of plain glass windows in wood sash and frames, metal clad on outside. The floor consisted of two thicknesses of planking on heavy creosoted timbers and creosoted piling over water. Draft curtains under wharf floor were spaced same as those under roof, extending down 4 feet below floor.

Fire Protection.

With the exception of the space under the pier deck, the building was protected with automatic sprinklers. Sprinklers were upright on exposed piping, spacing averaging 70 to 80 square feet per sprinkler head. A row of

outside open sprinklers along the roof peak was supplied with city water and provided with two-way fire department pumper connections.

Water supplies were adequate. A primary supply from city mains gave 106 pounds pressure at the highest line of heads. A secondary supply consisted of a 40,000-gallon wooden tank elevated 72 feet above grade on a wood tower and located 45 feet away from the pier. An auxiliary supply consisted of a siamese connection for fire department pumper located at east end of building and a 6-inch connection for the fireboat located at the west end. Fire alarm boxes were located in the building.

First aid equipment was available in the form of thirty-two 2½-gallon and two 40-gallon soda and acid extinguishers, four 1-quart carbon tetrachloride extinguishers and eight standpipes with 50 feet of 2½-inch hose each. This equipment was maintained in good condition at all times.

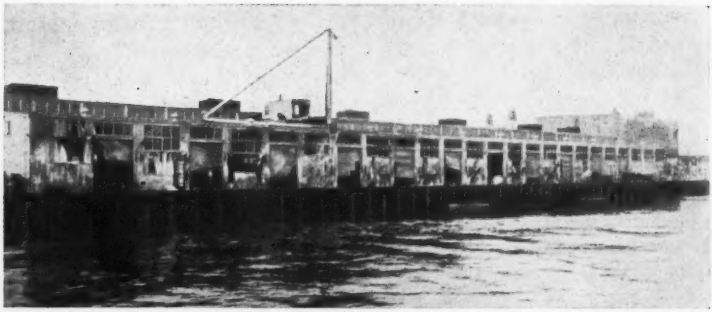
Story of the Fire.

A few wisps of smoke coming up through the dock just outside of the northwest corner of the warehouse were noticed by dock employees shortly after 3:10 P.M. The situation did not appear serious, but it was decided to notify the fire department by using the auxiliary fire alarm box in the warehouse. This alarm reached the fire department at 3:28 P.M.

In the meantime an attempt was made to extinguish the fire using a 40-gallon portable chemical tank, but these efforts were futile as the fire spread throughout the unsprinklered space under the wharf with great rapidity, aided by the light wind and the highly flammable coating of creosote and bilge oil on the pilings and timbers. The men tried to use a 2½-inch hose from a standpipe within ten feet of where the smoke was first noticed, but it proved difficult to handle and was abandoned in favor of the chemical tank. The bulkheads extending downward beneath the docks were of little value in retarding the fire as the flames passed under them and around the ends without difficulty.

The first engine company to arrive entered the warehouse with their apparatus, but were forced to abandon their equipment by the dense clouds of thick smoke. Several firemen and employees were trapped, but later rescued. The apparatus was recovered undamaged after the fire was under control. A second alarm was sent in at 3:42 P.M. and a third at 3:48 P.M., bringing a total of 23 engine companies, 4 truck companies, 2 squad companies and 2 fireboats. With the exception of the first company responding, all of the pumpers were operated from the street and a fireboat was assigned to each side of the pier.

Dense clouds of thick smoke from the burning creosote were not only spectacular, but also greatly hampered the efforts of the fire department. During the greater part of the time the building was completely hidden from sight with the exception of the northwest corner. The steamer *Mauna Ala*



South side of wharf after fire. Note corrugated iron sides and rolling steel doors battered by fireboat streams.

was towed out into the stream during the early part of the fire, but not before the flames had attacked the superstructure of the vessel. They were extinguished by the ship's crew.

The fire was almost entirely confined to the space under the pier deck and very little damage was incurred inside of the warehouse. Practically all of the piling and floor timbers were charred, but apparently none of the piles were burned through and it is doubtful that any considerable number will need replacement. Flames communicated through hollow frame partitions to the small ceiling space of the second floor office of the northeast corner and burned a small hole through the roof. A small hole was burned through the roof on the north side. The roof was not otherwise affected by the fire, and the open sprinklers on the roof were not needed. Considerable damage from fire was suffered by the east wall, and the corrugated iron sheathing and rolling steel doors on the north and south walls were ripped open and torn by the action of the powerful streams of the fireboat.

The interior of the warehouse, except in one corner, was practically undamaged. Observations of the sprinkler equipment indicate that the well-preserved condition of the interior of the building was very largely due to the action of the sprinklers, aided by the heavy floor construction. The appearance of the woodwork shows that the sprinkler heads along the outside walls nearly all fused and prevented damage to the roof structure and the skeleton wood frame to which the corrugated iron walls were fastened.

Due to the tight double flooring in the warehouse, all the flame and smoke from the underfloor space issued from the openings in the floor immediately outside of the warehouse walls. In the early stages of the fire only gases issued from the underfloor space, but they soon ignited, exposing the north, east and south walls to intense heat from the burning gases.

After the large number of pumpers got into action the water pressure in the city mains was reduced to such an extent that the gravity tank dis-

Interior of warehouse after fire, showing undamaged condition of woodwork.

charged into the sprinkler system and furnished water during the height of the fire. The warehouse was inaccessible from the land end, due to the immense volume of smoke, and as a result the fire streams from the land apparatus had to be thrown at the building blindly to a large extent; consequently it would have been impossible to prevent a general fire on the inside of the warehouse except for the automatic sprinkler equipment. The sprinkler equipment was shut off after the fire had been brought under control. An attempt was made to attach hose lines from a pumper to the automatic sprinkler siamese connection during the height of the fire, but due to the dense smoke the siamese connection could not be located. The conditions made it inadvisable to use the fireboat connection at any time during the fire.

A total of 858 sprinkler heads fused, probably 200 heads opening after the water supplies were shut off. It is likely that all of the heads in the roof would have opened but for the draft curtains which confined the heat to particular areas. After the fire a break was found in a swing joint in the 8-inch sprinkler main near the tank valves, which was caused by expansion of the sprinkler supply main under the wharf after the water was shut off from sprinklers. The value of the automatic sprinkler equipment during the fire was not impaired by this break.

The Mill Valley Conflagration.

Mill Valley, California, a San Francisco suburb, was visited on July 2-6, 1929, by a forest and brush fire which destroyed one hundred and thirty homes and caused a property loss estimated at more than a million dollars. The fire departments of six cities and towns were summoned in the effort to save the entire community from destruction.

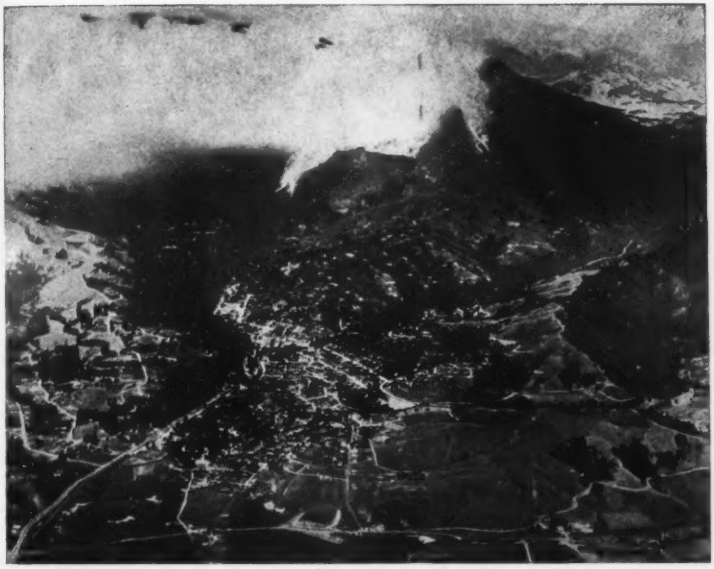
Mill Valley lies at the southern foot of Mt. Tamalpais. It is a residential suburb of San Francisco across the bay and is made up of homes of well-to-do business and professional men. It is a section of redwood, eucalyptus, oak, manzanita, bay, evergreen and similar vegetation. The entire countryside is heavily overgrown with brush, making the district one of the most luxuriant in northern California.

Several years ago Mill Valley suffered a similar disaster. Shortly after that threat the town, aided by the county and state, made a number of fire breaks through the thickly wooded country. The present fire showed that these breaks were not of sufficient width and probably had not been properly cared for during the past year or so, for in numerous spots the flames jumped the spaces. A number of two-inch hydrants were installed throughout the residential districts and these proved their value in this disaster.

The source of water for Mill Valley is Alpine Lake and from the watershed on the slopes of Mt. Tamalpais. The source in itself is both adequate and reliable, but arterial, gridiron and supply mains are inadequate to supply required fire flow, especially in the residential districts. A number of elevated tanks float on the system, filling at night or during low consumption and emptying during peak loads. Consequently during a fire of any duration, the supply is limited to that of the supply mains.

The fire started Tuesday, July 2, on the eastern slope of Mt. Tamalpais in what is known as Blythedale Canyon. The first alarm was sent out at 2:20 P.M. by the lookout on Mt. Tamalpais, who reported a fire outside the corporate limits. The town bell, used for outside alarms only, was rung and some 20 or 30 citizens responded. A crew climbed to the scene in a mountain train but soon found that the flames had almost surrounded them. They were forced to flee for their lives, leaving the engine and cars to be destroyed by the onrushing fire. The flames then traveled over the ridge, taking practically everything in their path. Desperate fire fighting saved several homes in this section, but many were destroyed with beautiful rugs, works of art and other contents valued at many thousands of dollars.

Note: This report has been extracted from information furnished by the Board of Underwriters of the Pacific, the *Pacific Coast Fire Chief*, and *Fire Protection*.



Underwood and Underwood.

The Mill Valley fire. Airplane photograph taken after the wind had changed on the second day. The main body of the fire is here sweeping up the slopes of Mt. Tamalpais.

At 2:45 P.M. an alarm was sent in from the Ralston White Estate inside the city limits. The siren was blown and the pumper responded with eight men, including the chief. No water for pumper use was available at this point and the efforts of the fire department had but little effect. Due to the dryness of the grass and underbrush of the eucalyptus forest, which trees shed leaves and bark which decay slowly and are readily combustible, it was not long before the fire was beyond control. A hasty appeal was made to all local citizens and others in the Bay region until soon the fire fighting force consisted of United States Rangers, members of the American Legion, soldiers from the Presidio and Marin County forts, firemen and apparatus from every Marin County town.

At 3:30 P.M. calls for assistance were sent to Sausalito and San Francisco, both cities responding, promptly. The San Francisco fire department arrived at about five o'clock with two pumper companies and two chemical companies. They had to journey four miles by ferry and six miles around winding highway. All pieces of apparatus made record time and connected to hydrants promptly. It was reported that differences in couplings caused delay. These reports were investigated by the Acting-Chief of the Department and it was found that the San Francisco Fire Department auxiliary

Sprinklers located on the roof of this dwelling, aided by garden hose and pumper streams supplied by a private swimming tank, saved this home from destruction, although the flames penetrated the garden on the east side.

equipment had been maintained to meet just such an emergency and the tie-up was made without any difficulty. It is said that some difficulty was experienced by fire companies responding from other towns.

The pumpers were stationed on the outskirts of the city and apparently had the fire under partial control when the near-by water tanks went dry, and as the small mains were unable to feed water from other districts in sufficient quantities, the men were forced back. The pumpers were relocated at strategic points surrounding the business section and the chemical engines were kept in the center of the town for the purpose of extinguishing fires starting from flying brands.

The fire continued to rush on, fanned and driven by a thirty-mile gale. In general, it spread in two ways, through the underbrush, dried leaves and grass, and by flying brands. A number of dwellings had wooden shingle roofs, this greatly increasing the number of sparks. About midnight, however, a shifting wind drove the fire back upon itself and the already burned area, and away from the business district. This, coupled with the efforts of the massed fire fighters, gave new hope and the gravest danger seemed to be past.

However, the rising sun of the following morning brought with it a rising and shifting wind which fanned the flames anew, blowing the fire over a ridge and into Cascade Canyon, which district suffered severely before the army of volunteers halted its advance, after which, due to the winds, the fire traveled back up another portion of Mt. Tamalpais. It was finally extinguished a day

or so later by the ceaseless efforts of the fire fighters aided by heavy fogs, which rolled over the mountains from the Pacific Ocean just beyond.

Sausalito, Larkspur, San Anselmo, Ross and San Rafael responded to the appeal sent out by Mayor Adolph Eberhardt on Tuesday night, July 2nd. Four pieces of equipment were sent from San Francisco and later four more pieces—the next day four more pieces were sent. While making twelve pieces in all, they were not all on duty at the same time, some being withdrawn early Wednesday and Thursday mornings. Eight were in action at one time. Those in authority reported that at one time there were 2,000 fire fighters on the long and irregular front, using wet sacks, axes, water, shovels, chemicals and every conceivable device for the quenching of fire.

Some of the San Francisco equipment pumped almost continuously for more than thirty hours, shutting down to move to new positions or when other occasions permitted. On July 4th two of these pumpers went practically all day with the throttle wide open, boosting water up the hill through 1000 and 1500-foot lines. At one time during the fire hose lines were stretched up the steep grade for 3000 feet.

During the course of the fire fighting there were many thrilling escapes from death and more than a score were injured, while light and power lines were put out of commission until July 5. The modern equipment used proved its efficiency under the most trying conditions. These engines were compelled to climb narrow mountain roads, force their way through brush and narrow streets and pump water from reservoirs, creeks and various other sources. To their efficiency and the competency of the mechanics and men who handled them Mill Valley owes its existence today.

The fire emphasizes again the value of fire-resistive roofs in such a district. In burned area homes with retardant roofs were only slightly damaged and in some instances escaped completely. Wooden shingle roofed houses went quickly.

There were two exceptions to this, however. Two large homes, set in a small valley branching off from Cascade Canyon, were saved despite the fact that the fire raged fiercely about them for hours. Both had wooden shingle roofs, but were equipped with roof sprinklers. These formed a curtain of water—sufficient to withstand the heat and flames until they passed beyond.

As is usual in such conflagrations, the citizens met while the fire was still burning and determined to put new protection measures into effect.

Refrigeration Fire Record.

Mechanical refrigeration on a large scale has been common in industry for many years, and with installations increasing rapidly it is becoming an important factor in present day economic life. Cold storage warehouses in the large cities hold thousands of tons of perishable foodstuffs. Artificial ice plants are increasing all over the country. Refrigerating machinery is found in ice cream factories, in meat packing establishments, in dairies and creameries, in wholesale and retail meat and provision stores, in candy factories, in hotels and restaurants, in fur storage and in other occupancies. Large apartment houses contain multiple refrigerating systems for the use of their tenants, and domestic units for the home are almost as common as was the automobile fifteen years ago.

As originally planned, this fire record was intended to cover cold storage warehouses and ice making plants, but a considerable number of fires in the N.F.P.A. fire record files attributed to mechanical refrigeration in other occupancies seemed to justify their inclusion as part of the record. This is by no means a complete record of all fires of this class, but it is sufficiently comprehensive to point out the fire and explosion hazards of refrigeration, embracing as it does a total of 208 fires occurring from 1900 to date.

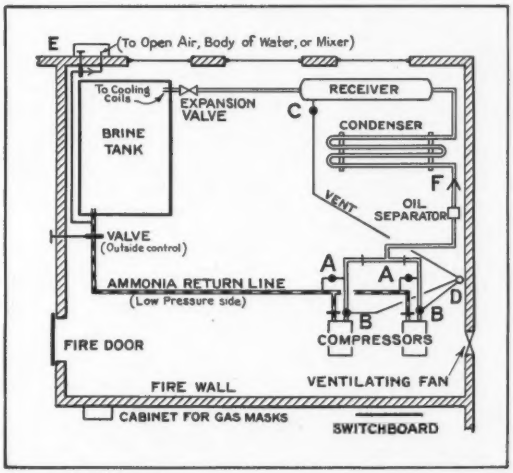
The data presented here have not been entirely confined to fires, but include a number of instances where explosions occurred involving refrigeration processes where no fire occurred. All fires occurring in cold storage warehouses and ice making plants have been analyzed and classified, but in other occupancies only those fires which have occurred in refrigerating rooms or processes have been included in this record.

It is not within the province of this fire record to go into detail as to the processes and hazards of refrigeration, but a brief outline of the two systems in most common use in commercial installations, together with mention of the gases usually employed seems pertinent. The hazards of household refrigerating machines were covered in a recent QUARTERLY article (Vol. 21, No. 4, page 192), and the hazards of the principal refrigerants classified in an article by Mr. A. H. Nuckolls in an earlier issue (Vol. 19, No. 2, p. 168).

Regardless of the type of occupancy, the large refrigeration plants commonly employ ammonia refrigeration systems. There are two types of system, compression and absorption. Both of these utilize mechanical power or heat to produce low temperature.

In the compression system the gas is compressed, thereby becoming heated. In the absorption system heat is used to drive off the ammonia gas under pressure from an absorbing medium, which may be a liquid or a solid.

From this point in either system the hot compressed gas passes through a condenser, where it is liquefied by cooling. The liquid thus formed passes through an expansion valve into piping or shell-type coolers at a considerably lower pressure. Then the liquid evaporates, and in so doing absorbs heat equivalent to that previously removed in liquefying the ammonia gas. Expansion of the gas at the lower pressure also absorbs a small additional amount of heat. The heat is taken from the surrounding medium, which is thereby cooled.



Factory Mutual Record.

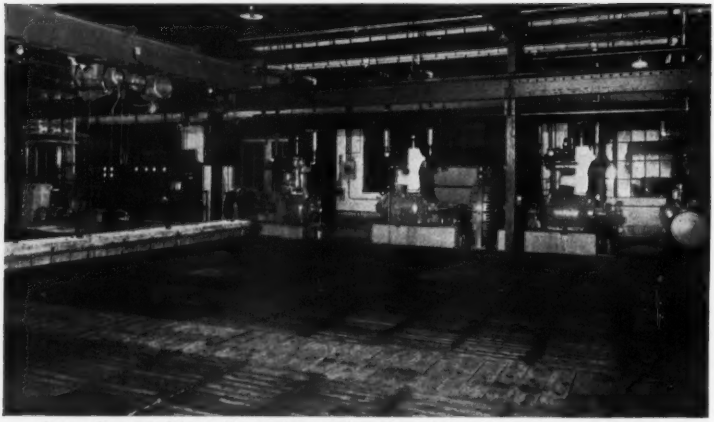
A Typical Ammonia Compression System.

Diagrammatic sketch showing automatic relief valves at A, B and C, and hand operated relief valve at E. A vent to the outside air is provided at D.

The gases most frequently used are ammonia, sulphur-dioxide, carbon dioxide, dichlor-ethylene, trichlor-ethylene, methyl chloride, and ethyl-chloride. Of these, ammonia is most commonly found in the large systems.

Pure ammonia is not regarded as flammable at ordinary temperatures. Liberated under pressure from a refrigerating system, however, it is both flammable and explosive. This is partly due to the presence of oil vapors mixed with the ammonia gas, the oil being used for lubrication and sometimes for cooling compressors.

By way of accounting for explosions of ammonia vapor suddenly released from high pressure, when not attributable to the presence of lubricating oil, it has been suggested that decomposition of the ammonia might take place, especially in the presence of an intense heat such as that of an electric arc light, resulting in the liberation of hydrogen which forms an explosive mixture



A modern refrigerating plant, showing three ammonia compressors in the background.

with air. It has also been suggested that certain impurities in the ammonia might increase the tendency to decomposition or explosion. In a number of the cases reported herein a definite explanation of just what caused the explosion of the ammonia vapor seems to be impossible, but the facts as nearly as can be ascertained are submitted.

Of the other gases, methyl chloride and ethyl-chloride are flammable; dichlor-ethylene and trichlor-ethylene are slightly flammable, but they are liquid at ordinary temperatures and in use are vaporized at lower than atmospheric pressure, so that there is slight danger from the rupture of equipment; carbon dioxide and sulphur dioxide have no fire hazard.

Accidents to large refrigerating systems are not frequent, for since the crippling of such a system generally results in a serious loss to goods in storage, engineers take great care to assure continued operation by proper installation and maintenance. Good installation coupled with intelligent handling and proper safety devices can do much to assure safe and continued operation of these systems.

Safeguarding a refrigeration system involves the use of devices for the prevention of high pressures which would cause rupture and provision against serious results if a rupture should occur. Sometimes duplicate equipment is provided so that the plant can function even though partially disabled by fire or explosion. Similarly, large systems supplying several sections need individual control valves so that any one section or room can be shut off without affecting the rest of the system.

That high pressures are a large factor in the cause of accidents in refrigerating systems is indicated by a compilation made a few years ago and published in "Live Articles on Special Hazards."

Class of Accident	Number of Accidents
Leaky joints	61
Bursting pipes	28
Explosion of ammonia vapors mixed with air	14
Liquid valves shut off on receivers	11
Liquid in compressors	9
Cylinder heads blown out without definite cause	9
Gaskets blown out	9
Defective valves	8
Generators burst	6
Ammonia leaks, miscellaneous	4
Pumping air with refrigerating machines for testing	3
Packing blowing out	3
Shutting off water supply in some manner	2
Brine cooler	1
Accidents prevented due to safety valves blowing	7
	175

The relative frequency of this sort of fire is difficult to determine, but a tabulation based on records of the New York Fire Patrol covering fires in cold storage and ice making plants indicates comparatively few fires occurring in these occupancies over a ten-year period. The table is interesting from

Ice storage room of modern ice making plant. All piping is located on the ceiling, away from mechanical injury.

another viewpoint, however, in that it shows a marked increase in the number of calls answered for ammonia leaks. It would seem reasonable to believe that this increase reflects the increasing number of systems in operation rather than indicating any increased hazard.

Number of Fires in Refrigeration Occupancies, New York City—1918 to 1927 Incl.

Year	Cold Storage Plants	Ice Mfg. Plants	Ammonia Leaks
1918	3	2	17
1919	3	5	13
1920	5	1	21
1921	3	2	24
1922	4	4	39
1923	6	7	24
1924	5	2	56
1925	2	4	59
1926	2	6	65
1927	0	6	90

The 208 fires included in this fire record are classified by occupancy as follows:

Cold Storage Warehouses		80
Ice Making Plants		69
Other Occupancies Involving Refrigeration		59
Packing Houses	19	
Wholesale and Retail Meat and Provision Store	14	
Ice Cream Manufacturing	5	
Breweries	4	
Creameries and Dairies	3	
Candy Manufacturing	3	
Dwellings	3	
Apartment Houses	2	
Restaurant	2	
Hotel	1	
Skating Rink	1	
Miscellaneous	2	
Total Fires		208

It is interesting to note that the greater number of the fires studied occurred while the plant was in operation. This is particularly true of those fires and explosions due to the special hazards incident to the occupancy.

	Cold Storage	Ice Mfg.	Other Occupancies
Plant in operation	39	32	26
Plant not in operation	24	15	21
No data	17	22	12
Total	80	69	59

Due to the demands placed upon large scale cold storage operations, the construction of buildings used for this purpose has, from the start, been either

Fire Engineering.

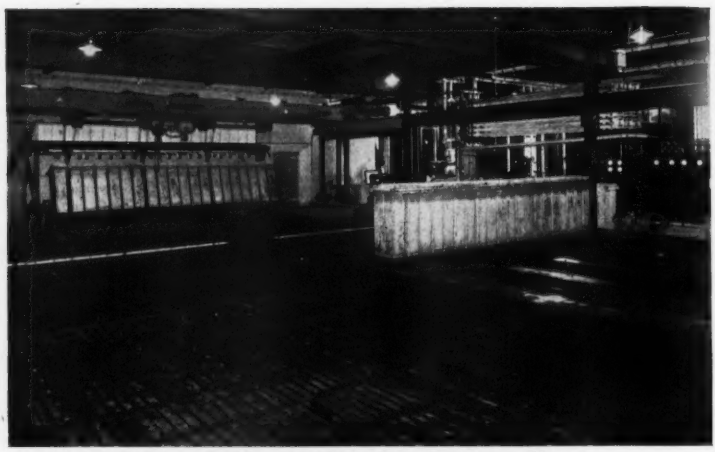
Exploding ammonia tanks in an ice plant at Spokane, Wash., injured six firemen and were a factor in causing a loss of $75,000 to the building.

brick-joist, mill or fire-resistive. This is indicated in the preceding tabulation by the fact that forty-five fires, or 73%, of the total number of fires in cold storage warehouses were in buildings of these classes of construction. The proportion of those occurring in brick-joisted buildings of heavy construction could not be ascertained, but it is reasonable to assume a fair number.

Of the fires occurring in fire-resistive buildings, thirteen were small or with a loss of less than $500, two were considerable, due to smoke and water damage to contents, and two were large, due to damage resulting from explosions of compressors.

Ice manufacturing plants show a predominance of fires in frame buildings. This is probably due to the fact that many of the early plants were of frame construction and additions were made from time to time to take care of the rapidly expanding business. Ice storage sections were insulated by filling the spaces between the studding with sawdust or ground cork. Very little in the way of providing proper cut-offs was attempted and fire protection was entirely lacking or inadequate.

This has been changed in the modern plants. Buildings are of brick with heavy joists or of fire-resistive construction; insulation is of cork board with cement plaster finish; hazards have been segregated and cut off, and effective fire protection has been provided. The nature of the business requires quantities of water in its operation, and it is not unusual to find pumping facilities ample for fire protection.



Ice room of ice manufacturing plant, Lynn, Mass.

Construction of Buildings Involved in Fires.

The type of buildings involved in fires is shown by the following table:

Type of Construction	All Occupancies	Cold Storage Warehouse	Ice Making Plants	Other Occupancies
Fire Resistive	30	17	4	9
Mill	5	3	0	2
Brick-Joist	64	25	19	20
Stone	2	0	2	0
Brick and Frame	3	2	0	1
Brick Veneer	2	2	0	0
Frame—Iron Clad	6	2	4	0
Frame	41	10	25	6
Concrete Block	1	1	0	0
Total—Known Construction	154	62	54	38
No data	54	18	15	21
Total	208	80	69	59

Point of Origin of Fires.

	Cold Storage Warehouses		Ice Mfg. Plants		Other Occupancies	
	No.	Per Cent	No.	Per Cent	No.	Per Cent
Engine Room and Refrigerating Equipment	11	13.6	18	26.1	24	40.7
Storage Sections	11	13.6	6	8.6	22	37.4
Boiler Rooms	11	13.6	10	14.5	1	1.8
Other Sections	23	28.4	8	11.6	11	18.3
Outside (Roofs—Exposure, etc.)	6	7.3	16	23.2	0	0.0
No data	18	23.5	11	16.0	1	1.8
Total	80	100.0	69	100.0	59	100.0

The dollars and cents figures for total known losses must be interpreted broadly as indicating a trend rather than loss figures for a given number of fires. From such analysis as it was possible to make, it appears that large loss fires in cold storage warehouses and packing houses were due to a considerable extent to damage caused by explosions of refrigerating equipment and to difficulty of fire fighting due to construction peculiar to the occupancy. In ice manufacturing plants inferior construction together with unprotected openings seems to have been a factor.

Analysis of Loss—Refrigeration Plants.

N.F.P.A. Fire Records, 1900-1929.

Occupancy	Total		Number of Fires								
	No. Fires	Total Known Loss	No. Fires Slight Loss	Loss Under $1000	Loss $1000 to $10,000	Loss $10,000 to $50,000	Loss $50,000 to $100,000	Loss Over $100,000	Large Loss, Not Definite	Loss Not Stated	No. Fires Involving Total Destruction
Cold Storage Warehouses	80	$941,359	19	7	10	10	7	4	13	10	7
Ice Mfg. Plants....	69	1,106,571	7	4	21	21	2	2	4	8	15
Packing Houses....	19	589,438	2	3	4	5	2	2	0	1	0
Wholesale and Retail Meat and Prov...	14	60,430	5	0	6	0	1	0	0	2	0
Ice Cream Mfg.....	5	50,623	1	0	2	1	0	0	1	0	0
Breweries	4	No data	1	0	2	0	0	0	1	0	0
Creameries & Dairies	3	115,000	0	0	0	1	1	0	0	1	0
All Other.....	14	No data	4	5	3	1	0	0	0	1	0
	208	$2,863,421	39	19	48	39	13	8	19	23	22

Butcher shop and dwelling in Brooklyn, N. Y., wrecked by explosion of refrigerating plant located in basement. Note hole in party wall.

Sprinkler Fire Record.

Relatively few of the buildings in which these fires occurred were equipped with automatic sprinklers. Nevertheless the performance of sprinklers was uniformly good, controlling the fire in all instances.

The small number of sprinklered fires is primarily due to the fact that a relatively small proportion of refrigeration plants have been equipped with automatic sprinklers. Also, where sprinklers are installed, such fires as occur are often controlled with the opening of one or two sprinklers and a negligible loss, and so are not reported. Partial sprinkler installations protecting hazardous portions only are frequently found in these properties, which accounts for the relatively large number of fires where the sprinklers were not a factor.

Effect of Sprinklers.

	Cold Storage	Ice Mfg.	Other Occupancies	Total	Per Cent
Extinguished Fire....	9	2	7	18	60.0
Held Fire in Check...	5	1	6	12	40.0
Total Satisfactory....	14	3	13	30	100%
Not a Factor.....	5	0	5	10	
Total.....	19	3	18	40	

Three of the reports of fires where automatic sprinklers were a factor and operated successfully did not contain sufficient data for further tabulation. Therefore the following tables give an analysis of the operation of automatic sprinklers at 27 fires.

Comparison of Wet and Dry Systems.

	Wet	Per Cent	Dry	Per Cent	Total	Per Cent
Extinguished Fire...	6	50.0	10	66.7	16	59.3
Held Fire in Check.	6	50.0	5	33.3	11	40.7
Total.....	12	100.0	15	100.0	27	100.0

Analysis of Sprinkler Operation.

No. of Heads Opening	No. of Fires Wet Systems	Dry Systems	Total	Per Cent
1	5	3	8	29.6
2	0	1	1	3.7
3	1	1	2	7.4
4	0	1	1	3.7
5	0	1	1	3.7
6–9	2	1	3	11.1
10–25	0.	3	3	11.1
26–50	3	3	6	22.3
Over 50.....	1	1	2	7.4
Total.....	12	16	27	100.0

Analysis of Loss.

	Wet	Per Cent	Dry	Per Cent	Total	Per Cent
Small Loss.....	9	75.0	11	73.5	20	74.0
Large Loss (Over $5000)	1	8.7	3	20.0	4	14.8
No Data.....	2	16.3	1	6.5	3	11.2
Total.....	12	100.0	15	100.0	27	100.0

Refrigeration Fire Causes.

N.F.P.A. Fire Records, 1900-1929.

	No. Fires	Per Cent of Known Causes
Special Hazard Causes.		
Refrigeration Machine Causes.		
Cylinder Head of Compressor Blew Off	6	3.9
Explosion in Compressor	4	2.6
Blow-out of Receiving Valve	3	1.9
Break in Ammonia Pipe Line	2	1.3
Explosion Due to Excess Pressure	2	1.3
Explosion in Oil Receiver	1	.7
Defective Electric Pump	1	.7
Explosion in Condenser Tank	1	.7
Glass Indicator Broke, Releasing Gas	1	.7
Ammonia Tank Exploded	1	.7
Hydrogen Formed in Brine Tank Ignited by Test Match	1	.7
Total Refrigeration Machine Causes	23	15.2
Other Special Hazard Causes.		
Overheated or Defective Refrigerator Motor	8	5.3
Gas Fumes Ignited by Open Flames	7	4.6
Asphalt Tar on Floor or Insulated Walls Ignited by Gasoline or Acetylene Torch	5	3.3
Cork Insulation Ignited Spontaneously or by Hot Tar	5	3.3
Friction Due to Belt Slipping	3	1.9
Insulation too Near Boilers	2	1.3
Insulation Ignited while Thawing Pipes	2	1.3
Use of Candle in Testing Eggs	2	1.3
Miscellaneous	7	4.6
Total Other Special Hazard Causes	41	26.9
Total—All Special Hazard Causes	64	42.1
Common Causes.		
Heating	19	12.5
Electrical Causes	13	8.6
Smoking—Matches	9	5.9
Spontaneous Ignition	9	5.9
Sparks on Roofs	9	5.9
Miscellaneous	16	10.6
Total Common Causes	75	49.4
Incendiary	6	3.9
Exposure	7	4.6
Total Known Causes	152	100.0
Unknown	56	
Total Number of Fires	208	

From the foregoing table it will be seen that 42% of the fires are due to special hazard causes, but as in other occupancies common causes predominate. For the most part these are preventable causes, due either to defects in construction or to carelessness on the part of occupants. A brief description of some of the more recent interesting special hazard fires follows, but a brief analysis of the fires due to common hazards is presented here.

Fires Due to Heating Equipment.

As a cause of refrigeration plant fires, heating led the lists of common causes. These fires were classified as follows:

	No. Fires
Combustible Material too Near Pipes or Boiler	6
Overheated or Defective Flue	4
Overheated Boiler or Stove	3
Hot Ashes	2
Sparks from Boiler	2
Explosion of Kerosene Stove	1
Fuel Tank Overflowed	1

Electrical Fire Causes.

Electrical causes claim their usual share of fires, with defective wiring and short circuits as the major factors. Fires classified under this cause include only those in which electrical causes are the contributory factor. When electrical causes are the primary factor in connection with refrigerating equipment they have been included under special hazard causes.

	No. Fires
Defective Wiring	8
Sparks from Motor	2
Short Circuit of Motor	1
Short Circuit in Oil Switch	1
Short Circuit in Transformer	1

Spontaneous Ignition and Miscellaneous Fire Causes.

Spontaneous ignition caused nine fires, four originating in coal piles and five in oily material or rubbish and sweepings. Sparks on wood roofs were the cause of nine fires, seven of which were in ice making establishments.

The miscellaneous classification of common causes included sixteen fires from sundry causes.

	No. Fires
Ignition of Flammable Liquids	3
Tar Kettle Boiling Over	2
Back-fire of Gasoline Engine	2
Careless Use of Acetylene Torch	3
Leak in Hose to Gasoline Torch	1
Hot Coal Dropped from Forge	1
Thawing Water Pipes	1
Filling Lighted Lantern	1
Lightning	2

Typical Explosions and Fires Involving Refrigerating Machinery.

NEW YORK CITY, DECEMBER 27, 1916. CANDY FACTORY. Fire supposed to have been due to spontaneous ignition of rubbish occurred in basement about 15 feet from a double pipe ammonia condenser. Heat from the fire melted the lead joints in the condenser, releasing the ammonia gas. This gas, probably foul gas composed largely of hydrogen due to disassociation of ammonia gases under heat or pressure, ignited and burned like a huge blow-torch under heavy pressure (probably 150 lbs.) maintained by the compressors.

It appears that the intense heat caused other leaks, and when the basement became saturated the flames shot through the entire section, scorching the ceiling, destroying pipe covering and damaging the contents.

Greater damage was averted through operation of dry pipe automatic sprinklers supplied by steamer connections at the sidewalk. Many heads opened, making it possible to get water on the fire quickly even though the fumes prevented the firemen from entering the basement. (S-20210.)

PHILADELPHIA, PA., FEBRUARY 6, 1918. ICE MANUFACTURING PLANT. This building was of brick construction, two-story in the front and three-story in the rear.

Fire occurred in a frame structure around a cooling apparatus located on the roof. It is thought that the wooden framework was ignited by a spark from a locomotive. Framework was destroyed and slight damage done to the roof. (H-13698.)

IOWA FALLS, IOWA, OCTOBER 20, 1919. PACKING HOUSE. An employee noticed a fire in the corner of the building and called the fire department by telephone and then tried unsuccessfully to extinguish the fire with a chemical extinguisher. After the fire department had arrived and had the fire practically under control, an explosion took place in some ammonia tanks which were stored in the building. A few minutes later another tank exploded, killing two men and injuring five others. Three buildings were destroyed by the fire and several others were badly damaged. (H-15897.)

WILLIAMSBURG, PA., JULY 16, 1920. ICE MANUFACTURING. Fire occurred in a fire-resistive transformer house caused by a short circuit in an oil switch, due apparently to rain water dripping through the 5-inch reinforced concrete roof.

Vents were so arranged in the north wall of the transformer house that the flames ignited wood doors and window frames about 3 to 6 feet distance in the angle formed by the machine and ice storage buildings. Loss was $780. (H-17190.)

WILMINGTON, DEL., JULY 18, 1920. ICE MANUFACTURING. The building involved in this fire was a 1-3 story, fire-resistive building. The fire occurred

in a frame pent house on the roof, completely destroying same and causing damage to ice in storage and insulation in roof space and walls. The roof (hollow tile on bare steel with slag covering) was damaged by several holes being made by the fire department, and the bare steel supports buckled slightly. Loss from $6000 to $8000. (H-16632.)

NEW YORK CITY, MAY 11, 1918. REFRIGERATING PLANT. One of the 225-ton ammonia compressors was in operation on the evening of the accident. Apparently a bolt on the bearing of the connecting rod at the crank shaft broke. The compressor, which had been turning at 208 r.p.m., stopped instantly and the water jacketed cylinder was wrecked. The centrifugal force of the flywheel caused it to break into pieces which tore down pipes in their path and damaged the building. The engine room immediately filled with ammonia gas and the employees of the engine room force, who escaped, were almost suffocated.

A fire alarm was sent in, but the fire department found it impossible to get near the building, due to ammonia fumes. Firemen with gas masks were proceeding towards the door of the plant to shut off the ammonia when an explosion with flame occurred. This was about 27 minutes after the accident to the compressor and was simultaneous with the operation of the circuit breakers in the power house of the local light and power company. This opened the 7500-volt circuit leading to the switch panel of the power company located in the compressor room of the cold storage warehouse. An examination after the accident showed fused copper on the insulated lugs for connecting cables to the oil switches. These lugs are separated about 8 inches, and the explosion of the ammonia vapor was apparently due to an arc between these terminal lugs resulting from a reduction of the insulation, presumably caused by the protracted discharge of the ammonia vapor assisted by the simultaneous discharge of water into the room from the supply to the cooling jackets of the compressor. (S-14235.)

PHILADELPHIA, PA., JUNE 10, 1919. ICE CREAM MANUFACTURING. This accident occurred with a compressor of small capacity used for refrigerating purposes in connection with the manufacture of ice cream. It had been recently installed on the first floor and was open in front to the street. Ammonia fumes permeated the neighborhood until exhausted.

The belt slipped off the fly wheel and an employee closed the relief valve on the machine. When the belt was readjusted the men forgot to reopen the valve, thus creating an excessive pressure which blew out one of the cylinder heads of the pump. The head was forced up through the floor above to the roof, and as the cylinders were encased in a water jacket, the latter was ruptured, blowing portions of it out into the street and severely injuring a passer-by.

No fire followed. The damage to the building was slight. (H-15571.)

ROSSLYN, VA., JULY 31, 1920. MEAT PACKING ESTABLISHMENT. Two mechanics were working with a lighted blow torch in a room adjoining the engine room, the door between the rooms being open. There were two ammonia compressors in the engine room and the end of one of these blew out. The escaping gas was ignited by the flame of the blow torch and an explosion occurred. The resulting fire destroyed a section of the plant. The loss was $7000. (H-16661.)

SYRACUSE, N. Y., JULY 14, 1921. COLD STORAGE PLANT. When first seen, fumes were pouring from a break in a 2½" discharge pipe which connected one of the 75-ton ammonia gas compression machines to the oil trap, which was in the line to the condensers. The oil trap drained the oil from the gas as it came from the compression machine, but in this case the break occurred in the line from the compression machine (where the oil is used) before the gas had passed the oil trap. Thus the gas as it escaped doubtless contained a sufficient amount of vaporized oil to form an explosive mixture.

The day had been exceedingly hot, and the heated air at the engine room ceiling mixing with the hot ammonia gas and vaporized oil escaping under pressure through crack in the pipe formed a readily flammable and supposedly explosive mixture. Whether this mixture was ignited by an electric spark from one of the numerous switches in the room or from contact with the fire in the boilers (the expanding gas could quickly and readily reach the boilers as they are not cut off) is not definitely known. But at any rate the gases were ignited and flashed back to the crack in the pipe. As the ammonia gas and vaporized oil were still confined under about 150 lbs. pressure at a temperature of about 200° F., the mixture exploded, ripping open the discharge pipe.

The flames spread to the upper floor. Fire department started to use ten hose streams, but four were abandoned due to fumes. Flames were not excessive and fire was soon put out. Ammonia fumes were hardest to combat and five smoke helmets were used before gas was finally shut off. Escape of gas could not be checked until three hours after the break. About five 100-lb. drums of ammonia were lost by the leak. Loss of several thousand dollars on building and contents resulted, but no damage was done to goods in cold storage. (H-17718.)

SAN FRANCISCO, CAL., NOVEMBER 1, 1924. ICE MANUFACTURING PLANT. Fire was caused by workmen who were welding a large steel brine tank with an acetylene torch when fresh paint on the tank ignited and set fire to the cork and tar coatings. The tank was being installed in a concrete pit.

The plant operator first tried to extinguish the flames with a hose stream which was too short and would not reach the fire, which had crept under tank. He then called the fire department. The fire created a very dense smoke, making it difficult to fight the fire. The firemen were forced to play streams

from door openings until the smoke partly cleared, at which time the streams could be directed under the tank and the fire extinguished. A hollow tile and wired glass partition kept the fire from extending into other parts of the building. (S-38243.)

PITTSBURGH, PA., MAY 22, 1925. ICE MANUFACTURING PLANT. An explosion and fire were caused by the rupture of one of the two ammonia separators located on the first floor of the manufacturing building just outside of the compressor room. There were no cut-offs. This separator was located on the suction side of the system in a return line from the ice tanks, and the normal suction pressure was about 30 pounds.

The rupture was probably due to some inherent weakness in the structure of the separator, which was in the form of a large iron drum designed to separate liquid ammonia and oil from the returning ammonia vapors before entering the compressors. The break allowed the entire charge of ammonia to escape, as there were no check valves on the system and no automatic power stops. Employees escaped from the compressor rooms as soon as possible following the flooding of the room with ammonia fumes, not even taking time to shut off the power.

A few minutes later an explosion occurred, followed by fire. It has not been definitely determined how the fumes were ignited, but it was assumed either by a small gas stove near the separator or by a spark from the D. C. generators in the compressor rooms. The ammonia fumes, mixed with oil rendering them explosive, and a drum of kerosene which was overturned by the force of the original break, probably increased the combustibility of the fumes.

The explosion and fire were not very severe and did little damage to the building itself. Many of the windows were blown out and some of the wiring equipment was wrecked by the explosion. The bulk of the damage was to large motors, transformers and other equipment being damaged by the water. Loss was estimated at several thousand dollars. (H-22198.)

TACOMA, WASH., MARCH 4, 1926. CREAMERY AND COLD STORAGE. This fire involved a modern building of mill construction. The fire occurred when removing cork sheets from a boiling tar vat. In taking the sheets from the vats the tar was spilled over the floor and the heater being gas, the tar became ignited. These sheets were used for covering the walls and the process of impregnating them with tar involved considerable hazard, for the tar was scattered all over the floor. Loss: $68,000. (H-23221.)

HARTFORD, CONN., JULY 19, 1926. APARTMENT HOUSE. A workman had been called to repair a "master" refrigeration plant in an apartment house. The plant used ethyl chloride in the refrigerating process. Fumes of this ignited from a near-by gas stove and the ensuing explosion killed the workman. This was the second fire from this type of refrigerating unit

which had occurred in Hartford. The fire chief stated that the distributors of this make of refrigeration plant would abandon the use of ethyl chloride as a result of this fire experience. (H-23553.)

ATLANTA, GA., SEPTEMBER 7, 1926. ICE MANUFACTURING PLANT. This plant consisted of several buildings—an old ice factory made up of three brick and joist buildings of from one to three stories in height, and a new ice storage building 1-5 stories in height of fire-resistive construction. This latter building had skeleton walls of reinforced concrete with a joisted roof having fire-resistive slab immediately under. There were openings from the fire-resistive building into the older ice factory, being protected by heavy wood refrigerator doors.

The fire apparently started from defective electrical equipment in the vicinity of the ice hoist motors in the old buildings. It gained considerable headway within a very short time and soon involved the entire upper part of the old buildings.

The new ice storage building resisted the fire in the old building for some time, but as soon as it gained a foothold it spread rapidly and burned with great intensity. The spread to the new building is thought to have been caused by the failure of the tile wall adjoining the new building. The wood sheathing, sawdust, cork, and wood floors inside also became ignited through wood refrigerator doors or the ruptured tile wall, or both.

As numerous other fires in fire-resistive buildings have gone to show, the presence of large amounts of combustible material renders this class of property hardly more desirable than brick buildings with roof and floors of ordinary wood joisted construction. In this particular class of occupancy the insulation that is necessary in ice and cold storage rooms confines the heat in case of fire, making it extremely intense inside the building. It further goes to show the desirability of the non-combustible material over sawdust and even block cork for insulation. (H-23786.)

ROCHESTER, N. Y., JANUARY 24, 1927. COLD STORAGE PLANT. A fire which started on January 24, 1927, smouldered in the inaccessible walls of a cold storage plant and baffled the firemen, who worked under great difficulty, due to cold weather and snow, for 89 hours before it was finally controlled.

The building was formerly a brewery, having been converted into a cold storage plant about 25 years ago. The building, some 50 years old, was of heavy brick and timber construction. Insulation consisted of 4-inch cork lining cemented to the outside brick walls, the cork being covered with ⅞ inch wood sheathing. Two by four studs were next erected and these in turn sheathed so that a 4-inch air space was provided in addition to the cork insulation.

The fire started near one of the refrigerating machines in the basement of the south end of the plant. Refrigeration was accomplished by the fan

Cold Storage Plant Fire, Rochester, N. Y., Jan. 24, 1927. The fire smoldering in the wall insulation was not brought under control for 89 hours. Ice and cold greatly hampered the firemen.

and duct method, cold air being blown from the basement through a brine room into wooden ducts leading to the various storage rooms. Apparently the fire followed this draft and from these ducts burned into the wall sheathing and cork insulation, thus spreading through the walls, in which it was totally inaccessible.

In the early stages of the fire twenty firemen were overcome by smoke, which could not be readily ventilated from the building. The fire was not brought under control until many holes had been drilled in the walls from the outside, thus providing ventilation and making it possible to apply water to the burning insulation. Loss: Estimated at $250,000. (H-24163.)

NEW ORLEANS, LA., AUGUST 4, 1929. STORE AND DWELLING. The building involved was a small one-story frame structure. In a small ventilated wooden cabinet were located the one horse-power motor and compressor for the refrigeration system. The motor was located approximately 1 foot from the ⅜-inch matched board partition at the back of the cabinet. The commutator end faced the partition. The fuses protecting the circuit, and the 220 volt single phase motor were of the cartridge type, 20 amperes capacity.

On August 4, 1929, at 6:52 A.M., the partition was discovered on fire. The motor had overheated, and the windings in the motor were destroyed. Circumstantial evidence points to the overheated motor as the cause.

Two active fire hazards that are not direct National Electrical Code violations may be listed as responsible for the damage.

First:—Motors such as refrigerator motors that are left in operation during the night, when commercial buildings are not occupied, should be so safeguarded that a burnout in a motor will not ignite surrounding combustible material.

Second:—Motors of less than 2 H. P. should be protected by time element circuit breakers that will open the circuit when the current value reaches 125% of the motor rating at not more than a 40 degree Centigrade rise in temperature.

NOTE: Other interesting fires are covered in the pamphlet "Refrigerating Machinery Explosion and Fires," reprinted from the QUARTERLY of October, 1916.

Fires in Which There Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred that they may be known and guarded against.

Automobile Accidents.

H-28100. TRENTON, N. J., AUGUST 2, 1929. One child was fatally burned and twenty-eight other persons, mostly children, were burned by flaming gasoline in an unusual accident. A truck had turned over and a crowd had gathered. An unidentified man thoughtlessly removed the cap from the gasoline tank of the truck. The fuel ran on to the hot engine and exploded, spraying the crowd with flaming liquid.

H-28101. SACRAMENTO, CALIF., AUG. 11, 1929. An automobile containing a party of Chinese returning from a wedding collided with another car, overturned and caught fire. Of the eight Chinese in the car six were burned to death and the other two were severely burned.

H-28117. PLYMOUTH, WIS., SEPT. 16, 1929. One man was burned to death and two other passengers were injured when a bus in which they were riding collided with another car, overturned, and burst into flames.

Boat Fire.

H-28107. ENFIELD, ME., AUG. 25, 1929. A man was drowned in Cold Stream Pond when a motorboat which he was operating alone caught fire. He jumped overboard to escape the fire but was unable to swim.

Children Alone in House.

L-446. HAMILTON, MASS., JULY 16, 1929. A two-year-old child, while asleep in his crib in the second story of a house, was burned to death when the dwelling caught fire from an undetermined cause. Several attempts were made to rescue the child, who had been left alone in the house with his small sister, but nothing could be done, as the house was enveloped in flames. This child was suffocated before the firemen could reach him.

Children and Matches.

L-440. BOSTON, MASS., JULY 8, 1929. A seven-year-old child died at a hospital as the result of burns received when her clothes were ignited by a match thrown by another child toward a pile of rubbish which a group of children had gathered intending to have a bonfire. Instead of falling into the rubbish the match struck the dress of the child and immediately transformed her into a living torch.

L-443. NORTH ADAMS, MASS., JULY 16, 1929. A six-year-old girl died of burns received when a playmate threw a lighted match which set fire to her

clothing. The child's mother was also burned in an attempt to extinguish the blazing dress.

L-444. METHUEN, MASS., AUG. 10, 1929. While her mother looked on, a four-year-old girl ran about the street with her clothing in flames after being ignited by matches with which she had been playing. Neighbors extinguished the flames with rugs, but the child died at the hospital of the burns.

L-445. DRACUT, MASS., AUG. 19, 1929. An eight-year-old girl died at the hospital after being burned while playing with matches. The child was playing with other children near her home. In some way she got hold of some matches and she and her playmate were lighting them when her clothing caught fire.

Fire Fighting.

L-439. EASTHAM, MASS., AUG. 21, 1929. While fighting a grass fire in the rear of his house an eighty-six-year-old man collapsed and died of overexertion. The fire which led to the man's death was believed to have been caused by sparks from a passing locomotive.

Fireworks Burns.

L-430. SAN FRANCISCO, CALIF., SEPT. 1, 1929. A twelve-year-old boy was fatally burned when he ran away from his mother as she tried to take away from him some fireworks which he had removed from a pile of discarded explosives. The friction of his clothing as he ran is said to have ignited the powder, and in a moment the boy was the center of a terrifying display.

Fireworks Store Fires.

H-27949. ST. LOUIS, MO., JUNE 29, 1929. A fire, caused by the ignition of fireworks illegally displayed on sales counters in a five-and-ten cent store, occurred when electric lights insecurely attached by an amateur electrician to arches above the counter fell into the display. A panic resulted which took four lives. The victims were unable to reach the exits, due to the quickly spreading fire. One victim was a salesgirl and the other three were children, customers in the store. Several persons were injured. Quick access for fire fighting and rescue work was hampered by the limited number of exits, three doors in all. The loss was $44,000.

H-27961. OMAHA, NEB., JULY 3, 1929. Two lives were lost when an explosion occurred on the fourth floor of a large fireworks store. Automatic fire doors confined the fire to one section of the building.

Forest Fires.

H-28103. CHELAN NATIONAL FOREST, WASH., AUG. 14, 1929. After being missed for ten days, the bodies of two men were found in the Chelan National Forest, where they had been trapped while directing the fight against the forest fire at Camas Creek.

H-28110. SMITH CREEK, WASH., AUG. 31, 1929. A forest fire-fighter was killed and another was seriously injured when a snag fell on them while they were fighting the Smith Creek forest fire in Washington State near the Canadian line.

H-28118. BELL MOUNTAIN, WASH., SEPT. 16, 1929. A rancher was burned to death and his wife and son were seriously burned when the Bell Mountain forest fire destroyed their home. Other ranches were destroyed by two great forest fires which were sweeping through Oregon and Washington at the time that this fatality occurred.

Institution Fire.

H-28111. MEMPHIS, TENN., SEPT. 1, 1929. Eight negro children lost their lives when they were trapped in a bathroom when fire swept the settlement house in which they were living. The children had fled to the bathroom while trying to escape from the flames. The fire was started by a negro orphan girl who was "mad" because she had been punished. Conditions in the home were evidently not of the best.

Starting Fires with Kerosene.

L-426. REMOVAL, W. VA., SEPT. 14, 1929. Burns received while trying to start a fire in her kitchen stove with kerosene proved fatal to a young woman, despite heroic efforts of a young man school teacher who dragged her into a near-by stream to extinguish her flaming clothing.

L-433. CONCORD, N. H., AUG. 17, 1929. Six lives were lost in a fire which destroyed a home on the outskirts of the city. It is thought that the fire which destroyed the flimsy dwelling was caused by pouring kerosene on the stove fire. The father died trying to rescue his children, four of whom died. A neighbor's boy, who was helping the father care for the children, was also killed. The mother was away at work when the fire occurred.

Oil Field Fire.

H-28114. WINK, TEXAS, SEPT. 8, 1929. Three oil field workers were burned to death in the bath house at an oil plant when they used gasoline to remove grease from their bodies. Their clothing had become saturated with oil while they were working on a well. A heater in the room is thought to have ignited the gasoline fumes.

Oil Refinery Fire.

H-28102. WILMINGTON, CALIF., AUG. 13, 1929. Five oil workers were killed and another was critically burned as a result of an explosion in a cracking still at a large oil refinery. The blast was caused by gasoline fumes which escaped from a broken line in a "hot" room of the still coming in contact with the heat of the room. It was thought that either the pressure in the

gasoline pipe line passing through the room was too high or that a joint in the line was defective.

Rooming and Apartment House Fires.

H-28104. LITTLE ROCK, ARK., AUG. 19, 1929. Five persons were burned to death and several were injured in a fire which started with the explosion of a gas cooking stove in the kitchen of a large frame rooming house, mostly occupied by railway shop employees. The blaze spread rapidly through the building and all of the persons in rooms upstairs were trapped and fatally burned or were injured in leaping from the windows.

H-28106. NEWARK, N. J., AUG. 18, 1929. Four negroes, members of one family, were suffocated and thirty-six other families escaped when an oil lamp explosion started a tenement house fire during the early morning.

H-28109. NEW YORK, N. Y., AUG. 29, 1929. Five persons were killed or fatally burned when fire swept a four-story tenement house at 2 A.M. When the fire department arrived the building was well involved and the firemen had difficulty in getting the tenants out. One man was killed by jumping and four members of one family received fatal burns.

H-28112. WINNIPEG, MAN., SEPT. 1, 1929. Eight persons lost their lives when an apartment house was destroyed by fire. Ten other persons were seriously burned. Seven of the victims were trapped on the upper floors, where they died. The eighth victim died in a hospital. The tenants jumped into life nets and to the pavements in order to escape from the fire.

Self-sacrifice.

L-428. MEMPHIS, TENN., SEPT. 5, 1929. A thirteen-year-old Boy Scout gave his life in order to save his nine-year-old sister from the flames which seriously burned his father and two other sisters. The boy awakened to find his room blanketed with flames, rushed across the hall to his little sister and, while the flames licked his back, lowered her to the ground with bed sheets. He then wrapped a sheet about his head and leaped. He died in a hospital. His sister was badly burned.

National Fire Protection Association

INTERNATIONAL

Executive Office: 60 Batterymarch St., Boston, Mass.

The National Fire Protection Association was organized in 1895 to promote the science and improve the methods of fire protection and prevention, to obtain and circulate information on these subjects and to secure the coöperation of its members in establishing proper safeguards against loss of life and property by fire. Its membership includes over a hundred national and regional societies and associations and more than four thousand individuals, corporations, and organizations.

The QUARTERLY is one of a large number of publications issued by the Association and sent to the members as published. These include the monthly *News Letter*, standard regulations on fire prevention and fire protection, special reports and bulletins, the Year Book, and the Proceedings of the annual meetings.

Membership in the National Fire Protection Association is open to any Society, Corporation, Firm or Individual interested in the protection of life or property against loss by fire. All the valuable engineering and popular literature issued by the Association is sent, as issued, to every member. The Association is the clearing house for all the authoritative information on Fire Protection and Prevention, and members are privileged to submit to it their individual problems for solution. The Association is always glad to send samples of its publications to prospective members upon request.